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AN EXAMINATION OF SEASONAL SHIFTS IN CLIMATE AND VISITATION,
AND PERSPECTIVES ON SEASONAL SHIFTS AND CLIMATE ADAPTATION
STRATEGIES IN TOURISM AND RECREATION BUSINESSES FOR

MOAB, UTAH

by

Elizabeth Cook

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Geography

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Logan, Utah

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ABSTRACT

An Examination of the Relation between Climate and Visitation, and Perspectives
on Seasonal Shifts and Adaptation Strategies in Tourism and Recreation
Businesses for Moab, Utah

by

Elizabeth Cook, Master of Science

Utah State University, 2019

Major Professor: Claudia Radel, Ph.D.
Department: Environment and Society

The city of Moab, an outdoor recreation hub in eastern Utah, has been encountering both a shift in the seasonality of visitation, and increases in tourist visitation, even with summer temperatures above the normal high. Tourism research describing the effects of climate change on the outdoor recreation industry has focused on winter, snow-dependent activities, while studies in Moab city have focused on the economic value of outdoor recreational activities. Few studies have described the relationship between seasonal tourism and climate change for arid desert locations. The purpose of this study is to describe how the tourism and recreation industry in Moab, Utah is experiencing and adapting to changes in climate. The first part of the research is a regression between monthly national park visitation and climate factors (long-term monthly average temperature and temperature anomaly) that influence tourism

seasonality in Arches National Park and Canyonlands National Park. The second part of the research uses an online survey to identify how seasonality shifts are perceived by different actors in Moab and how they are responding to manifestations of climate change.

Regression results indicate that as air temperature increases in the region around Moab, national park visitation also increases. Moab businesses are not directly adapting to climate change, but are adapting to perceived increases in visitation throughout the year. The majority of Moab businesses do not attribute the increase in visitation to climate variables, instead visitation increases are believed to be a result of the popularity of the town and the region.

(109 pages)

PUBLIC ABSTRACT

An Examination of the Relation between Climate and Visitation, and Perspectives on Seasonal Shifts and Climate Adaptation Strategies in Tourism and Recreation

Businesses for Moab, Utah

Elizabeth Cook

The city of Moab, an outdoor recreation hub in eastern Utah, has been encountering both shifts in the seasonality of visitation, and increases in tourist visitation, even with summer temperatures above the normal high. Tourism research describing the effects of climate change on the outdoor recreation industry has focused on winter, snow-dependent activities, while studies in Moab city have focused on the economic value of outdoor recreational activities. Few studies have described the relationship between seasonal tourism and climate change for arid desert locations. The purpose of this study is to describe how the tourism and recreation industry in Moab, Utah is experiencing and adapting to changes in climate. The first part of the research is a regression analysis of existing data, exploring the correlation between monthly national park visitation and climate factors (long-term monthly average temperature and temperature anomaly) that influence tourism seasonality in Arches National Park and Canyonlands National Park. Using an online survey, the second part of the research identifies how seasonality shifts are perceived by different actors in Moab and how they are responding to manifestations of climate change. Regression results indicate that as temperature increases in the region around Moab, national park visitation also increases. Moab businesses are not directly

adapting to climate change, but are adapting to perceived increases in visitation throughout the year. The majority of Moab businesses do not attribute the increase in visitation to climate variables, instead visitation increases are believed to be a result of the popularity of the town and the region.

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INTRODUCTION

Nature-based tourism is a key component of the tourism industry in the United States, especially with regard to national parks and protected areas (Scott, Jones, and Konopek 2007). Outdoor recreation and nature-based tourism within the United States' Rocky Mountain region has a history of continuous and increasing growth for western rural economies with an increasing number of communities embracing tourism (Van Patten 1996; Smith and Krannich 1998). Climate directly influences outdoor recreation and tourism by increasing or limiting demand (e.g., number of people willing to raft under certain conditions), regulating when activities can occur (e.g., season), and restricting the quality of an experience (e.g., mountain biking in extreme heat conditions versus mild spring conditions) (Scott, Jones, and Konopek 2007). Scott et al. (2007), Richardson and Loomis (2004), and Monahan et al. (2016) argue that changes in climate such as increasing temperature could positively influence visitation to national parks. Changes in park visitation that coincide with warmer climate would positively benefit parks and the economies of gateway communities, but they could also lead to increased environmental pressure and the need to adapt to higher levels of visitation (Scott, Jones, and Konopek 2007).

Moab, Utah is a rural tourism community that is encountering increases in visitation by tourists throughout the year to nearby national parks (Grand County Utah 2017; National Park Service 2017a, 2017b) and is a popular outdoor recreation hub, even with hot summer months (U.S. Climate Data 2018). Moab is a gateway community for tourism and outdoor recreation in Arches National Park, Canyonlands National Park, Utah state parks, and public lands managed by the Bureau of Land Management and

Forest Service (Figure 1) (Grand County Utah 2017; National Park Service 2017a, 2017b). Tourism research previously conducted in Moab has focused on the economic value of certain types of tourism and outdoor recreational activities, but has not explored the relationship between seasonal tourism/recreation, changes in climate, and adaptation practices (Fix and Loomis 1997; Chakraborty and Keith 2000; Fix, Loomis, and Eichhorn 2000). As temperatures continue to rise in the area, especially during the hot summer months, visitation rates may be negatively impacted or shift to other times of the year (Fisichelli et al. 2015). Increases in temperature can have a positive influence on visitation to a certain comfort threshold, before extremely high temperatures drive visitors away from outdoor recreation and tourism (Richardson and Loomis 2004). With potential change in visitation during the summer, the tourism and recreation industry may have to adapt to accommodate changes in visitation that are a direct result of climate change.

This thesis research describes how the tourism and recreation industry in Moab, Utah is experiencing and adapting to climate change. There are two parts to this thesis research: part one regresses monthly visitation and climate factors (long-term monthly average temperature and temperature anomaly) to understand changes to tourism seasonality. The second portion of the research identifies how seasonality shifts are perceived by different actors in Moab and how they are responding to manifestations of climate change using a qualitative survey.

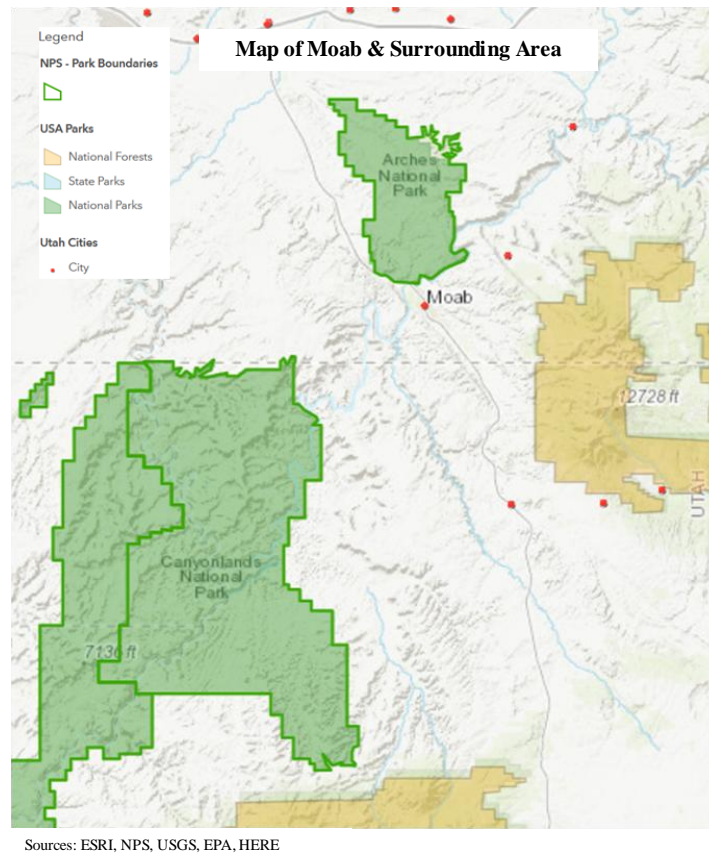


Figure 1. Map of Moab and surrounding areas including federal public land. Moab, Utah is a gate way community for two national parks, national forests, and state parks.

Research Questions

This research addresses the overarching question of how the tourism and outdoor recreation sector in Moab is experiencing and adapting to climate change. The purpose of this research is to increase the understanding of how local businesses in the community are responding to shifts in visitation and physical environmental changes (e.g., shifts in the amount of snow/rainfall, temperature changes, water river levels), and to understand how climate change is influencing visitation to national parks that are connected to Moab.

This case study in Moab, Utah helps to fill a gap within existing studies, and also provide important data for the local community on changes that are occurring and how they are being experienced by different industry actors. By analyzing existing historical visitation and temperature data from January 1979 to September 2017, and qualitatively surveying tourism and outdoor recreation industry actors, the study provides relevant information for community policy decisions especially with concern to community wellbeing and sustainability initiatives. The study also contributes to broader understanding of climate change impacts and experiences in relation to tourism and outdoor recreation. The sub-questions below are addressed as part of the larger question.

- 1) Is there evidence of monthly visitation patterns occurring, and what do those patterns look like?
- 2) Is temperature correlated to monthly visitation?
- 3) How do different Moab industry actors (e.g., various businesses) perceive and experience seasonal visitation shifts?
- 4) How and to what extent, if any, are these actors responding to seasonal visitation shifts they experience or anticipate, and/or to other observed or anticipated manifestations of climate change?

In this study, increasing visitation is hypothesized to be a response to climate change (Scott, Jones, and Konopek 2007; Pegg, Patterson, and Gariddo 2012). With shifts in visitation, tourism and outdoor recreation businesses within the community are potentially adjusting their businesses to accommodate visitation changes that are influenced by the physical environment (Koenig-Lewis and Bischoff 2005). A further

hypothesis is that tourism and outdoor recreation businesses that have the ability to do so are increasing resources and facility use during seasons they otherwise would not consider, such as the shoulder season and winter off-season (Koenig-Lewis and Bischoff 2005).

LITERATURE REVIEW

Seasonality and Tourism Visitation

Current research on tourism seasonality has started to examine climate change and adaptation plans (Nicholls 2006; Amelung, Nicholls, and Viner 2007; Scott, Jones, and Konopek 2007). Seasonality has many definitions within tourism research; it can be the “recurring changes in the rate of activity attributable to the influence of climatic and conventional seasons” or the temporal imbalance in tourism that is “expressed in terms of number of visitors, traffic and other forms of transportation, employment, and admissions to attractions” (Koenig-Lewis & Bischoff 2005, 202). Most research describes seasonality as a “sort of pattern in the visits that reoccur every year,” but does not include a quantifiable definition that includes when seasonality for tourism occurs, guides the differentiation of seasons, or creates a method for comparing regions or annual change (Koenig-Lewis & Bischoff 2005, p 202).

Seasonal visitation has a diverse set of causes that can generally be broken down into weather, calendar events, and timing decisions (Koenig-Lewis & Bischoff 2005). Causes like calendar effects and events (holidays and days in a month), and timing decisions (school vacations, bonus payments, etc.), are more stable over an extended period of time, while others like weather are more unpredictable (Koenig-Lewis & Bischoff 2005). Natural seasonality is the variation in climate throughout the year, including temperature, precipitation, snow, amount of daylight and sunshine, etc. (Koenig-Lewis and Bischoff 2005; Pegg, Patterson, and Gariddo 2012). Institutional seasonality refers to “traditional temporal variations formed by human decisions that are

often enshrined in legislation,” such as public holidays, summer vacation for schools, and practices that reflect social norms of the society (Koenig-Lewis and Bischoff 2005, 204).

Seasonality for tourism is mainly driven by natural seasonality and institutional seasonality, and outdoor tourism activities especially rely on weather and climate for attraction visitation (Koenig-Lewis and Bischoff 2005; Pegg, Patterson, and Gariddo 2012).

Some research argues that fluctuations in visitation cause social and personal strains in the local community, while other research argues that seasonality allows the ecological and socio-cultural parts of the environment to recover during an off-season (Koenig-Lewis and Bischoff 2005; Pegg, Patterson, and Gariddo 2012). From an economic standpoint, seasonality is viewed as a problem because resources are not being utilized efficiently (Pegg, Patterson, and Gariddo 2012). Peaks in tourism activities over a short period of time can result in inefficiency in the industry, and can stress the local community physically and socially (Koenig-Lewis and Bischoff 2005). During peak seasons, overcrowding and congestion are likely to occur, which leads to higher demand for services and pressure on local infrastructure (Pegg, Patterson, and Gariddo 2012). Seasonality can cause lower quality standards of service in peak months if visitation becomes higher than the capacity a place, business, or city can handle (Koenig-Lewis and Bischoff 2005; Pegg, Patterson, and Gariddo 2012). Economically, seasonality is viewed as an issue of inefficient utilization of resources during the off-season because of the “non-utilization of infrastructure, a reduction in the work force,” and decrease in revenue (Koenig-Lewis and Bischoff 2005; Pegg, Patterson, and Gariddo 2012, 660).

Other research has shown that the community expects the negative consequences of seasonality, and does not view them as a problem to be resolved (Pegg, Patterson, and Gariddo 2012). Some stakeholders argue that seasonality is highly beneficial because it permits a recovery period for permanent residents, allowing for renovation, community stress-relief from the feeling of being overwhelmed by tourists, and gives the environment time to recover (Pegg, Patterson, and Gariddo 2012). Pegg and colleagues (2012) explain how environments that receive a high number of visitors during peak times need a period of recovery to rebound from over usage.

Seasonality has major economic, ecological, and socio-cultural impacts on a space. The methods that communities use to minimize impacts are very diverse, including reducing facilities and resource supplies to restrict overcrowding, increasing facilities and resources during peak season, reducing demand in the peak season (through price increases or fees), increasing demand outside of the peak season (introducing a second season or modifying activities available), and restructuring the supply through product diversification (Koenig-Lewis and Bischoff 2005). Research is still unable to answer questions around what is an “optimal” amount of seasonality for a region and how changes can be implemented over a diverse business sector to address some of the impacts of seasonality (Koenig-Lewis and Bischoff 2005; Pegg, Patterson, and Gariddo 2012).

Climate Change's Influence on Outdoor Recreation and Tourism

Environmental seasonality among plant communities has seen a shift from 1901 to 2012 with an “earlier spring and a longer growing season” linked to climate change (Monahan and Fisichelli 2014, 2). In dry regions, water availability is a large driver in phenology events, and changes in climate are influencing water sources (Monahan et al. 2016). Biome-scale vegetation models suggest that, due to climate change, mountain parks in Canada’s Rocky Mountains will undergo “latitudinal and elevational environmental changes with potential for species reorganization and loss of biodiversity” (Scott, Jones, and Konopek 2007; Scott et al. 2016). As noted in national park studies, spring is starting earlier (Monahan et al. 2016), and projections suggest that parks in the Rocky Mountains region will experience climate-induced biophysical changes (Scott, Jones, and Konopek 2007; Monahan et al. 2016). On average, “spring commencement is already earlier than 95 percent of the historical range of spring onset dates since 1901” (Monahan et al. 2016, 7).

A change in spring onset will not only influence the timing of park operations and the behavior of animals “reliant on maintaining phenological synchrony with plants” in a region (Monahan et al. 2016, 10), it will also impact visitation, land-use, and local events, including seasonal festivals and outdoor recreation (Scott, Jones, and Konopek 2007; Copeland et al. 2017). Changes in seasonal visitation patterns that occur as a result of a changing climate will not happen in isolation; visitation will be indirectly influenced by climate change through shifts in the physical environment that tourism and outdoor recreation rely on (Scott, Jones, and Konopek 2007).

Since many tourist and outdoor recreation activities rely on favorable weather conditions, and climate change has the potential to impact visitation for outdoor recreation destinations, the effects of climate change need to be considered. Climate directly influences outdoor recreation and nature-based tourism by increasing or limiting “when specific recreation and tourism activities can occur, recreation and tourism demand, and the quality of an experience” (Scott, Jones, and Konopek 2007). According to Higham and Hall, “understanding and responding to climate change represents one of the more important, complex, and challenging issues facing the contemporary tourism and recreation industries” (Nicholls 2006, 151). Tourism research has examined the relationship between climate variables and visitation to understand how climate change might affect the relative attractiveness and seasonal visitation at destinations (Becken 2013; Rosselló-Nadal 2014). The direct impacts of climate change on tourism include shifts in precipitation, humidity, temperature, wind speed, and other climate variables that have a major influence on outdoor activities and experiences for participants (Nicholls 2006; Scott, Jones, and Konopek 2007; Becken 2013; Rosselló-Nadal 2014).

Climate variability over time has not received much research with regard to the effect of temperature anomalies on visitation or tourism. Temperature anomalies are the difference between what you expect and the actual recorded temperature. They depict how a region has warmed or cooled when compared to a period of time (Ichoku 2018). Temperature anomalies allow for more accurate descriptions over larger areas than actual air temperature (Wheeling Jesuit University and NASA 2018). Anomalies have been used extensively in climate science research examining global temperature, long-term climate

change, historical climatology, and atmospheric patterns (Mock et al. 2007; Smith et al. 2008; Loikith and Broccoli 2012; Huhtamaa 2015; Anchukaitis 2017; Kamae et al. 2017; Ichoku 2018; Wheeling Jesuit University and NASA 2018). Hower & Gough (2016) are some of the only tourism and recreation researchers to have examined if temperature anomalies affect visitation. They studied seasonal temperature anomalies and zoo guests to understand the climatic context that influenced zoo visitation. They calculated seasonal climate normals (thirty year averages for temperature and precipitation) and then “identified which years recorded anomalously warm or wet seasons” (Hower and Gough 2016, 7). The results explained that anomalously warm winters and springs lead to significantly higher seasonal zoo attendance, while anomalously warm summers lead to significantly lower attendance levels (Hower and Gough 2016).

With a global trend toward warmer weather, there may be a shift in tourist destinations around the world as some places become more attractive (Agnew and Viner 2001). Koenig-Lewis and Bischoff suggest that short-term warmer temperatures during the summer months may encourage visitors to favor domestic locations instead of international destinations (2005, 204). Short-term warmer weather fluctuations provide more favorable climate conditions for short spontaneous trips and the potential for the extension of the holiday seasons (Koenig-Lewis and Bischoff 2005). Many communities in the Rocky Mountain Region that rely on domestic and international winter recreation and tourism are increasingly influenced by the effects of climate change (Archie 2014). In ski regions particularly, ski operations are becoming more concerned with their

vulnerability to climate change with warmer winters and less natural snow (Pegg, Patterson, and Gariddo 2012; Archie 2014).

A study conducted by Fisichelli et al. (2015) shows a strong relationship between visitation and temperature in national parks. In some parks with “historically warm temperatures” there is “potential future decrease in visitation during the hottest months of the year,” but with an increase in the overall visitation season (Fisichelli et al. 2015, 5). With parks experiencing increased visitation in warm weather, increasing spring temperatures over the coming decades are expected to cause earlier peak attendance to national parks (Buckley and Foushee 2012). Scott et al.’s (2007) research on national park visitation behavior models projected that the direct impact of climate change would increase visitation under an extended and augmented warmer tourism season. Park managers and the communities surrounding national parks need to focus on managing the impacts of climate change for conservation mandates and increasing visitation over the coming years as a result of a lengthened warmer weather tourism season (Scott, Jones, and Konopek 2007).

Richardson and Loomis (2004) conducted a similar study to that used visitation analysis to measure the effects of climate change scenarios on visitation to Rocky Mountain National Park (RMNP). When park visitors were presented with scenarios that depicted hypothetical changes in climate and weather, temperature was found to be “a positive and significant determinant of visitation behavior” (Richardson and Loomis 2004). The results indicated that increases in temperature would encourage increases in visitation except for in the case of extreme heat (Richardson and Loomis 2004). In the

Extreme Heat climate scenario, results estimated an 8.75 percent decrease in visitation, which is supported by RMNP visitation numbers from the summer months of 2002 that were 8.8percent lower than the previous year (Richardson and Loomis 2004). Richardson and Loomis's (2004) survey results also communicated that the majority of visitors to RMNP planned their trips far in advance and RMNP was their primary reason for taking the trip.

In research examining visitation to Utah's five national parks, Smith et al. (2018) found that the monthly average of the daily maximum temperature was a great predictor of visitation to Utah's national parks. Visitation was shown to increase to the national parks as the monthly average of the daily maximum temperature increased (Smith et al. 2018). However, when the average daily max temperature threshold is between 25°C and 33 °C, there was a decline in visitation for Canyonlands National Park and a leveling off in visitation to Arches National Park (Smith et al. 2018). Decision makers in communities with already very warm temperatures, such as Moab, will have to consider how "when and where people travel will change" and "the types of services/facilities will need to respond to changing demand" (Fisichelli et al. 2015, 10).

Adapting to Climate Change in the Community

"In contrast to mitigation, which seeks to reduce emissions of greenhouse gases affecting the climate system, adaptation aims to prepare for and respond to changes that have already occurred and will occur regardless of how aggressively emissions are reduced" (Jantarasami, Lawler, and Thomas 2010, 2). To moderate potential impact from

changing visitation for specific points in time, local businesses and community decision makers may need to exploit various opportunities such as increased recreation in shoulder seasons: spring and fall (Fisichelli et al. 2015). In years with below-average snowpack and lower streamflow, revenue for snow- and water-based recreation businesses is generally lower compared to wet years, which has the potential to threaten long-term profit margins (Alvord et al. 2008). With unfavorable climate conditions, businesses may raise prices or invest in alternative activities to help cover economic loss that occurs (Alvord et al. 2008). “Local communities dependent on tourism are potentially impacted by climate variability and change,” seasonally and yearly (Alvord et al. 2008). Tourism-dependent communities are challenged in retaining steady business activity and permanent residents year round (Alvord et al. 2008).

“Economic stability, technological capability, the location and character of the population,” and management will largely influence the impact of climate change (Sasidharan et al. 2001, 58; Archie 2014). Adaptation strategies to address issues related to precipitation, drought, and steady revenue can vary greatly depending on the community (Alvord et al. 2008). Improved drought forecasting, early drought warning systems, and smaller, lighter boats for rafting are adaptive technologies that communities can adopt to handle below-average low-streamflow (Alvord et al. 2008). Adaptive technologies such as improved drought forecasting and drought warning systems act as early warning systems so communities can prepare in advance for below-average snowpack and reduced streamflow that can influence skiing and water tourism (Alvord et al. 2008). Alternative activities and increased diversification in local industry that take

advantage of warm and dry conditions are possible adaptations for some tourism businesses in the Colorado Plateau (Alvord et al. 2008). Some of those alternative activities could include rock climbing, jeep tours, road biking, or 4-wheel off-roading (Alvord et al. 2008). Dry regions that will be threatened by extreme heat or unpredictable snowfall could potentially benefit greatly from activity diversification and an expanded revenue base (Sasidharan et al. 2001; Wyss, Luthe, and Abegg 2015).

A shift in seasonality to encourage some visitation in the shoulder seasons could potentially increase economic benefits to local communities, especially those that rely on tourism and recreation (Fisichelli et al. 2015). In regions with more extreme climates, evidence shows an important shift toward all-season operations with alternative types of outdoor recreation especially in many traditional ski regions (Pegg, Patterson, and Gariddo 2012; Archie 2014). Ski operations are already using adaptation strategies like creating snow, opening during the summer, opening for shorter time periods in a season, or reducing operation size (Alvord et al. 2008; Pegg, Patterson, and Gariddo 2012; Archie 2014).

Communities that are smaller and more dependent on their natural areas will have limited options compared to communities that have well-funded public recreation areas within their region (Sasidharan et al. 2001; Kaján, Tervo-Kankare, and Saarinen 2015). Many of these already at-risk communities have increased vulnerability due to the lack of power they possess over managing key recreation areas on public lands (Archie 2014). In a study conducted by Archie (2014) on Southern Rocky Mountain recreation and tourism communities, some of the largest barriers to good management identified were “budget

constraints, development decisions, political will and stakeholder conflicts.” Archie argues that in places like the Inter-Mountain West, federal and state agency management practices do not always “align with the interests of the local communities” because layers of policy can create a barrier to adaptation (2014, 571). Her results found that “even if there is general willingness on behalf of the community, lack of support from elected officials may prevent adaptation planning from going forward,” and a lack of leadership prevents the development of planning options and changes in policy (Archie 2014, 581).

An important social barrier to adaptation planning, nationally and internationally, is a lack of urgency regarding adapting, which “has been linked to attitudes and beliefs about climate change” (Saarinen et al., 2012; Archie, 2014). However in the same work by Archie (2014), research found that decision makers who reported higher levels of belief in climate change also reported higher levels of adaptation planning, but this finding applied to only 23 percent of respondents. Within Inter-Mountain West communities, elected officials overall had lower concern about climate change which suggests a lack of political will to make progress on adaptation decisions (Archie 2014). Internationally, Saarinen and colleagues researched tourism communities in Botswana, which also lack urgency in adapting currently because they do not believe their operations are currently affected (2012). Instead, they believe the community will be affected in an arbitrary future time (Saarinen et al. 2012).

Other research has examined the potential impacts of climate change on international tourism and the global economy (Agnew and Viner 2001), measured the effects that weather has on tourism in countries like New Zealand (Becken 2013), and

examined how climate is impacting natural resources the tourism industry relies on throughout North America (Scott, McBoyle, and Schwartzentruber 2004). In current tourism and climate change literature, researchers have emphasized how important research and planning for climate change is for outdoor recreation and tourism to minimize the potential negative impact to the local environments and communities (Nicholls 2006; Pegg, Patterson, and Gariddo 2012). There are many tourism and recreation studies on the effects that climate change will have on ski operations and snow dependent regions, and more research is needed for many other regions of the world (Sasidharan et al. 2001; Koenig-Lewis and Bischoff 2005; Pegg, Patterson, and Gariddo 2012; Archie 2014). Places like Moab that will be experiencing increases in already warm temperatures and rely on tourism, lack research on their vulnerability and exposure to the effects of the climate change. More research needs to be conducted to understand how prepared warm tourism-dependent regions are; what are the beliefs and attitudes of business owners, land managers, and political leaders toward climate change adaptations? Are other barriers such as financial resources, social expectations of shorter seasons, or policy hindering decision making?

Moab in Research

Tourism research previously conducted in Moab and the surrounding public land has focused on the economic value of certain types of tourism and outdoor recreational activities (Fix and Loomis 1997; Chakraborty and Keith 2000; Fix, Loomis, and Eichhorn 2000), resident attitudes towards visitors (Van Patten 1996), and seasonal visitation characteristics (Steed, Roberts, and Eastep 2014). Van Patten (1996) surveyed Moab

residents to measure residents' attitudes toward tourism. She found that "residents recognized both the positive and negative sociocultural impacts of tourism with more emphasis placed upon the negative" (Van Patten 1996). Residents more strongly agreed that tourism causes (1) a strain on emergency services, (2) crowding in recreation areas, (3) overuse of local services, and (4) a shift away from rural characteristics. General attitudes towards tourists were slightly positive.

At the state level, there was research conducted in central and southern Utah on differences in seasonal visitation characteristics for domestic and international travelers by Steed et al. (2014). Domestic travelers were separated into four groups based on residence (U.S. Pacific, U.S. Mountain, U.S. Central, and U.S. East Coast), with Pacific state residents represented more in the spring and summer seasons, Mountain states more represented in the fall and winter seasons, and East Coast residents represented more in summer and the least in winter. International travelers were separated by country with English-speaking travelers (Great Britain, Canada, Australia, and New Zealand) "more represented in the spring, and least represented as a group in winter" (Steed, Roberts, and Eastep 2014). Travelers from France, Netherlands, and Belgium had heavy representation in the summer. Travelers from Germany, Austria, and Switzerland were more represented in the spring and summer months. Visitors from Japan and other countries were more common in the fall and winter. Arches National Park and Canyonlands National Park, near Moab, were visited by 36.8 percent and 20.4 percent of surveyed visitors. The percentage of travelers to Arches National Park was relatively evenly split through each season, while the percentage of travelers to Canyonlands National Park was higher in

summer (26.6%) and spring (26.6%). The top five respondent activities were visit national/state parks (79.5%), touring/sightseeing (70.4%), hiking (65.2%), visit historic sites (46.1%), and visit a museum/ art exhibit (27.1%).

The Colorado Plateau, a dryland ecosystem with sparse vegetation and hyper-arid to sub-humid landscapes, encompasses part of Utah, Colorado, Arizona, and New Mexico (Copeland et al. 2017). Ecological and land-use research of the Colorado Plateau, which includes Moab, is exposing how dryland ecosystems will be impacted more negatively by the “combined effects of multiple types of high-intensity land-use,” climate change, and aridification (Copeland et al. 2017, 3). Land-use in a study by Copeland et al. (2017) includes the overlap between cultivated agriculture, grazing, recreation, and energy development. The study noted how parks and recreation areas throughout the Colorado Plateau have experienced increases in visitation, and have an elevated potential for high overlapping land-use with energy development (Copeland et al. 2017). Copeland and colleagues’ results suggest that “higher intensity of land-use and climate [change] are likely to lead to increased conflict and added complexity for resource management for ecological integrity, energy production, and recreation” (2017, 19).

Studies outside of Moab, Utah, have explored how increases in temperature encourage increases in tourism visitation (Scott, Jones, and Konopek 2007; Fisichelli et al. 2015; Smith et al. 2018), and extremely high temperature could potentially change tourism seasonality (Richardson and Loomis 2004; Smith et al. 2018) or cause locations to become less attractive to visitors (Amelung, Nicholls, and Viner 2007). Adaptation and the ability to adapt to climate change in tourism-dependent communities has been the

focus of several case studies, nationally and internationally (Sasidharan et al. 2001; Alvord et al. 2008; Jantarasami, Lawler, and Thomas 2010; Saarinen et al. 2012; Archie 2014). With an increasing amount of research recognizing the importance of tourism seasonality and the influence of climate change on outdoor recreation and visitation to national parks, this study will help fill a gap in existing literature on the influence of climate change on Moab and tourism to the region (Richardson and Loomis 2004; Koenig-Lewis and Bischoff 2005; Scott, Jones, and Konopek 2007; Pegg, Patterson, and Gariddo 2012; Fisichelli et al. 2015).

STUDY METHODS

This research used mixed methods drawing from qualitative survey data and existing quantitative data to inform the research questions. Mixed methods allow the local Moab businesses' narratives to be combined with numerical data on visitation and environmental factors, which provides richer, more complex results (Hesse-Biber 2010). Mixed methods provide complementarity, so a fuller understanding of the research results are achieved than otherwise obtained through only analyzing qualitative or quantitative data (Hesse-Biber 2010). In this case, the two methods were used to address different sub-questions within the overall research aim.

Existing quantitative datasets were analyzed to understand the two sub-questions: (1) Is there evidence of monthly visitation patterns occurring, and what do those patterns look like? (2) Is temperature correlated with monthly visitation? First, visitation data were analyzed to identify seasonality patterns over time. Then existing temperature data were analyzed for correlation with visitation. Of the available measures of climate change and environmental factors, temperature was chosen because research has shown that tourists are particularly receptive to changes in this variable (Jones and Scott 2006; Amelung, Nicholls, and Viner 2007; Scott, Jones, and Konopek 2007). The method for analysis was a multivariate regression, with visitation as the dependent variable. The sections titled Temperature and Visitation Data and Analysis Methods provide more detail on the data and multivariate regression analysis methodology.

Primarily qualitative survey methods were utilized to understand the experiences of local business owners in Moab, since they provide insight into social characteristics

(community dynamics), behavior, values, attitudes, and perspectives (Hay 2010). A survey was used to explain, (1) How do different Moab recreation and tourism industry actors perceive and experience seasonal visitation shifts? (2) How and to what extent, if any, are these actors responding to seasonal visitation shifts they experience or anticipate due to manifestations of climate change? Under the sub-headings Survey Data Collection, and Analysis Methods, more detail on the content of the survey and code book analysis are provided.

Study Area

The city of Moab is located in southeastern Utah, within Grand County, and had approximately 5,242 permanent residents in 2016 (U.S. Census Bureau 2016). It is located near the Colorado River, Green River, and the La Sal Mountain Range on the Colorado Plateau (Bearnson 2017). The arid desert landscape is characterized mostly by sandstone and limestone, hot summer temperatures, cool winters, and irregular precipitation (National Park Service 2015). Moab is a gateway community for Canyonlands National Park, Arches National Park, Dead Horse State Park, Sand Flats Recreation Area, the La Sal National Forest, and thousands of square miles of BLM and Forest Service land (Moab Area Travel Council 2017).

Originally founded as a farming, ranching and fruit growing region, Moab's economy and population boomed with uranium mining and the production of the U.S.'s second largest uranium processing mill in the 1950s (Bearnson 2017). In the 1970s, tourism became one of the largest industries in Moab because of surrounding public lands, national parks, films featuring Moab's landscape, and famous slick-rock mountain-

biking trails (Holtby 2012; Bearnson 2017; Moab Area Travel Council 2017). Citizens of Moab are concerned about greenhouse gas emissions for a variety of reasons and have passed a resolution to have the city drastically reduce emissions and commit to 100 percent renewable energy by 2032 (Egelhoff 2016). Based on local visitation statistics dating from 1979–2017, more visitors are coming to experience the National Parks around Moab today than did around forty years ago (National Park Service 2017a, 2017b). The region typically receives the majority of its visitors during spring and fall, and visitation to the national parks is increasing across the whole year (National Park Service 2017a, 2017b).

Temperature and Visitation Data

The temperature and visitation datasets used in this study are from National Park Services, United States Geological Survey, and Utah Climate Center. For the purpose of understanding climate changes that businesses are adapting to, historical monthly temperature data were obtained from the Utah Climate Center. The monthly average minimum and maximum temperatures were obtained from two station locations: Arches National Park HQS station (Jun. 1980–Sep. 2017) and Canyonlands National Park–Neck station (Jul. 1965–Sep. 2017) (Figures 2 and 3). Each station has gaps in the weather data. Arches National Park is missing all variables for September 1990. Canyonlands National Park–Neck is missing all variables from February 1994 and July 2009. For the purpose of this study, weather data from January 1979 to September 2017 (a 38-year period) were used to understand long term climate trends for Arches National Park and Canyonlands National Park.

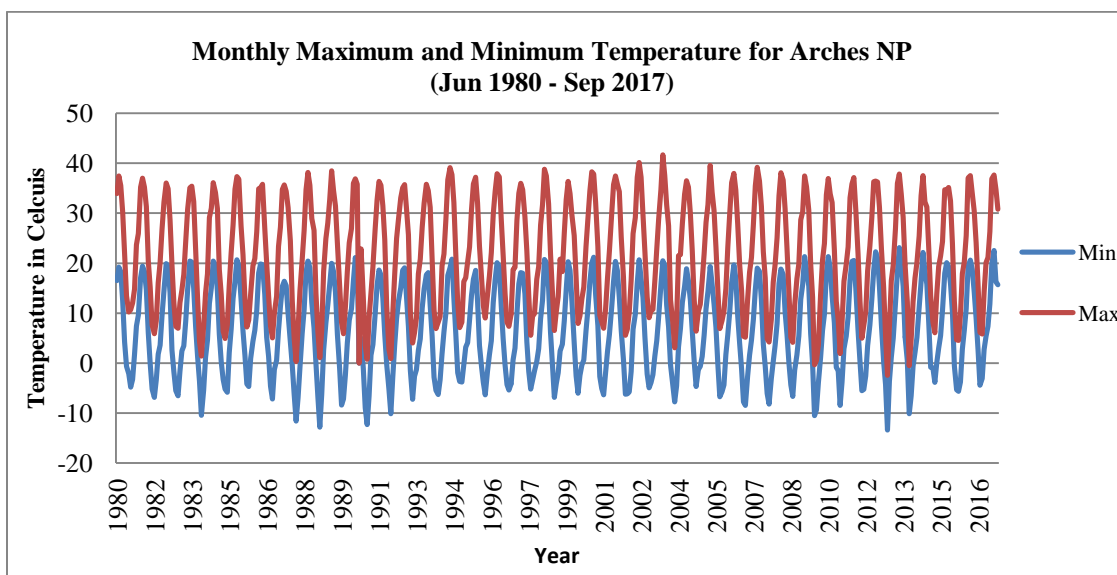


Figure 2. Arches National Park monthly maximum and minimum temperature in Celsius that dates from June 1980 to September 2017. The data demonstrates the general monthly temperature trends for the park.

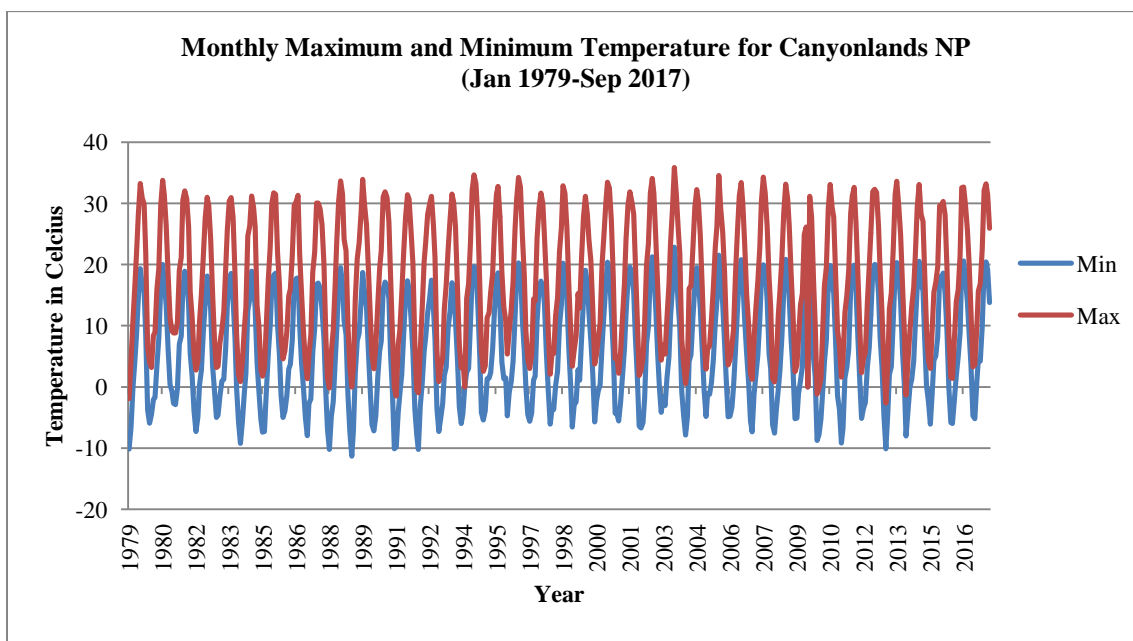


Figure 3. Canyonlands National Park monthly maximum and minimum temperature in Celsius that dates from January 1979 to September 2017. The data demonstrates the general monthly temperature trends for the Island in the Sky section of the park.

To capture visitation numbers for the area, quantitative data used include visitation information for neighboring national parks close to Moab. These datasets consist of aggregated data without any identifying information for individuals and are public, open access. The monthly visitation data provided by National Park Service are for Arches National Park and Canyonlands National Park from January 1979 to September 2017 (Figures 4 and 5). No long-term monthly visitation data are currently available for Moab City, so the researchers are unable to analyze trends between air temperature and visitation to the city itself.

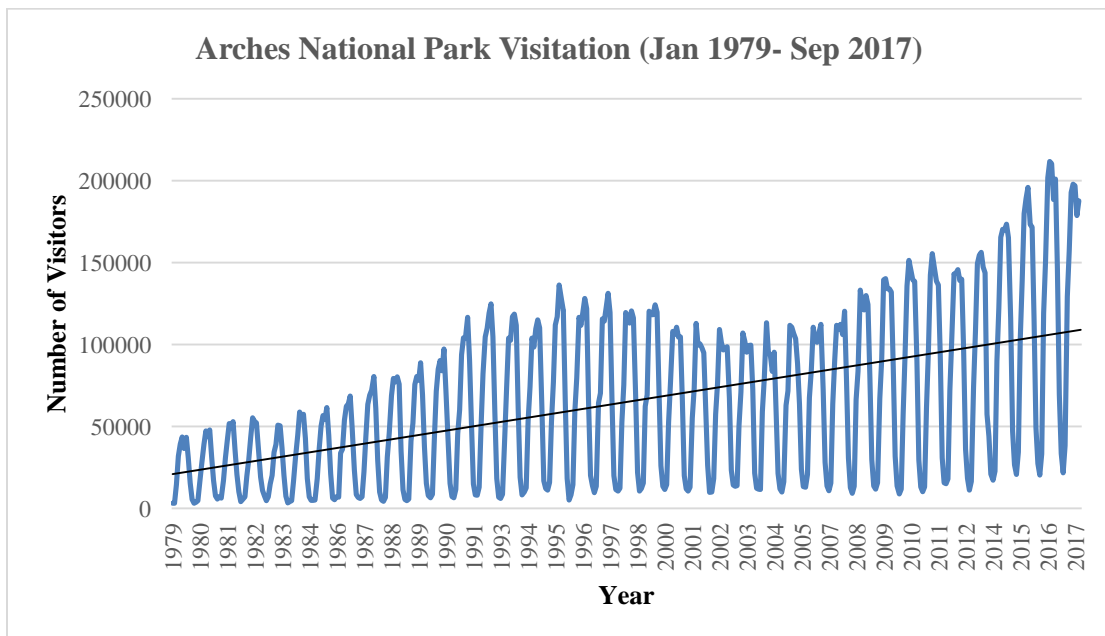


Figure 4. Arches National Park visitation. Monthly visitation data for Arches National Park from January 1979 to September 2017 showing an increasing trend in visitation.

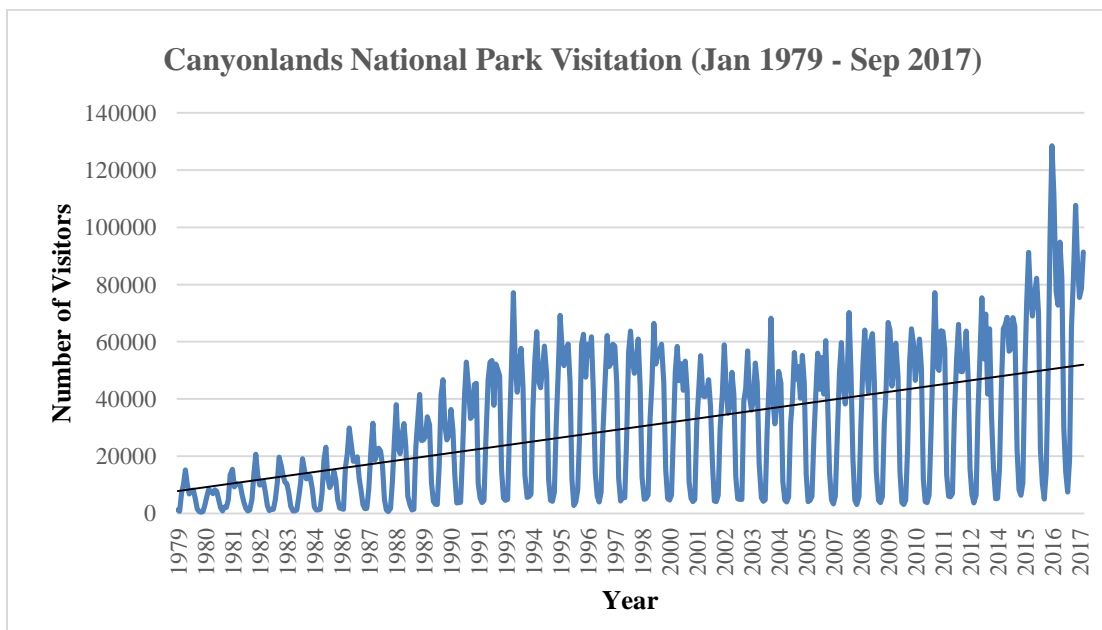


Figure 5. Canyonlands National Park visitation. Monthly visitation data for Canyonlands National Park from January 1979 to September 2017 demonstrating an increasing trend in visitation.

Survey Data Collection

A qualitative survey was designed to collect data from all businesses in outdoor recreation activities or tourism experiences, in Moab and the surrounding recreation areas. Eligible businesses did not include businesses that only offer hospitality services, dining, equipment purchasing (not including rentals), or sleeping accommodations. A list of all these businesses was created by searching through sources such as the Moab Area Travel Council (2017), the website Trip Advisor (www.tripadvisor.com, for public contact information on businesses and lists of businesses by recreation type), advertisements and brochures around Moab, the local paper (*Moab Sun News*), and a local advertiser (*Moab Happening*). Through these sources, public information on

company names, company addresses, business phone numbers and emails, operator or owner's names, types of services offered, and operation hours was collected.

The seventy-seven businesses included were separated into three categories for the purpose of the survey pre-notification process: no physical address, outside city limits, and in-town. Businesses were classified as 'outside city limits' if they were outside the city limits of Moab, Utah. The 'no physical address' category was included for businesses that did not possess a physical storefront location; in some cases, business owners run the operation from their personal home or from a location that visitors cannot access. The 'in-town' category was for businesses that possessed a physical storefront within the Moab city limits.

Supervisors, managers, and owners of eligible businesses were identified either by their public information or by employees during the pre-notification phase. The survey was distributed to all identified eligible operators and some businesses recommended more than one contact to enhance chances of completion. To increase the response rate, pre-notifications and follow-up reminder emails were utilized. The survey was distributed to supervisors, managers, and owners of eligible businesses through a cover email with a link to an online Qualtrics survey.

Qualtrics was selected as a way to reach all included businesses, as well as those that did not possess a physical location, or had a location outside Moab city limits while mainly servicing Moab. By using this method, owners, managers, or supervisors could privately express their perceptions of, and experiences with, any shifts in visitation they had encountered, and could speak to questions around climate change adaptation

strategies (Hay 2010). Additionally, online surveys possess the following advantages: respondents typically submit lengthy commentaries on open-questions (Hay 2010), distribution costs are lower (Andrews and Preece 2003), and when combined with follow-up notifications response rates are similar to mail-in and drop-off/pick-up survey methods (Cook, Heath, and Thompson 2000).

Initially, the researcher pre-contacted owners and supervisors in person or over the phone to highlight what the research is and to notify them about receiving an email to participate. In-person pre-notification was used for the businesses within Moab city limits, while businesses with no physical address or a physical location outside of Moab received a phone call. Studies suggest that the number of contacts, personalized contacts, and pre-notifications are instrumental to higher response rates (Cook, Heath, and Thompson 2000; Andrews and Preece 2003; Hay 2010). After pre-notification, a participation invitation email was sent with a link to the online survey and an informed-consent form. The invitation to participate highlighted again the nature and purpose of the research and the level of detail needed in the survey. A week after the initial email was sent, the researcher followed-up with owners and supervisors through additional emails to encourage participation. The additional emails included another invitation to participate, with a link to the survey and consent form. The survey was first distributed in September 2017 and was open until mid-November, 2017.

The survey included basic questions around the type of recreation the business promotes, months the business is open throughout the year, how visitation has changed for the business on a seasonal basis each year, if business adjustments have occurred

(e.g., new businesses hours, staff increases, increase in tours offered, later winter closers), and how environmental conditions are influencing the business. The second part of the survey asked questions pertaining to if changes in business practices have occurred, and how changes in climate/environmental conditions or changes in visitation might have affected the business. Participants were asked to explain if they were concerned about environmental factors influencing their business and if they are considering or implementing adaptation strategies. Before the survey was distributed to the outdoor recreation and tourism industry within Moab, the survey was tested by two local businesses to assess the resulting types of written responses and to examine the validity of the questions themselves. Additionally, two local researchers from Utah State University and the U.S. Geological Survey, who intimately interact with Moab industry actors, also evaluated the survey for question applicability to Moab. Survey completion was estimated to take less than forty-five minutes.

The survey included a mix of twenty-one closed and open-questions, but mainly relied on open-questions because of the greater potential for in-depth responses and to allow the respondents the ability to recount their own understandings (Hay 2010). Open-questions are designed to encourage a meaningful objective response using the participant's knowledge; they cannot be answered by a 'yes' or 'no' response. Open-questions allow information to be collected on "how meaning is attached to process and practice"—a qualitative research characteristic (Hay 2010). Closed-questions limit the response options for a participant through multiple choice, scaled, or two-point questions. Some closed questions were included, but they were not heavily utilized because of the

diversity amongst businesses and the lack of existing social science research available on Moab's tourism industry. In total, seventy-seven businesses in Moab received the survey with a resultant response rate of 29 percent, or twenty-two businesses.

Analysis Methods

For this study, temperature data were the climate variables selected to predict visitation because temperature has been identified by Becken (2013) to be a clear driver of seasonality in New Zealand, and by Scott et al (Scott, Jones, and Konopek 2007) to be the strongest predictor of monthly visits to Canada's Waterton Lakes National Park in the Rocky Mountains. Jones and Scott's research demonstrated that monthly mean temperature in a multivariate regression analysis was an important variable in understanding seasonal tourism (Jones and Scott 2006). Temperature and precipitation are the climate variables with the most extensive data dating back further than other variables that have been analyzed for their predictive effect on visitation such as wind speed, cloud cover, and relative humidity. However, precipitation data were excluded from the analysis because the national parks in the Moab region do not receive significant amounts of rainfall throughout the year, and the majority of precipitation is generally winter snowfall at high elevations and the short late summer monsoon season (Adams and Comrie 1997; NOAA 2013). Multivariate linear regression analysis for the existing datasets is appropriate to investigate the impact of air temperature on visitation based on similar research by Amelung et al. (2007), Becken (2013), Lise and Tol (2002), and Scott et al. (2007). For this study, multivariate linear regression analysis results can reveal

monthly visitation patterns and the relationship temperature has with national park visitation to better understand tourism seasonality for the region.

A multivariate regression analysis approach was utilized, using IBM SPSS Statistics software, to examine patterns over time with monthly visitation data as the dependent variables and air temperature, year, and months as independent variables (Figure 6). Two linear multivariate regression models were created with temperature and year as the independent variables, one for Arches National Park and one for Canyonlands National Park. Month variables were added as categorical dummy variables in order to indicate how each month influences visitation. The air temperature variables included for each of the two locations were the long-term average monthly temperature over a 38-year period, and anomaly for monthly temperature defined as the difference between the actual monthly average and the long-term average monthly temperature (Table 1). The dependent variable, park visitation, is the total count of all recorded visitors in a month over a 38-year period.

$$Y_i = (b_0 + b_1LTATemp_i + b_2TempA_i + b_3Month_i + b_4Year_i) + \epsilon_i$$

Figure 6. Multivariate linear regression equation. Y_i is the predicted or expected value of the monthly visitation variable. LTATemp represents the long-term average temperature variable. TempA represents the temperature anomaly variable. Month stands for the monthly dummy variables. Year represents the year variable, which predicts the influence of time.

Table 1. Description of variables in models

Arches National Park Model		
Variables	Factor	Description
Dependant Variable	Arches National Park Visitation	Monthly recorded park visitors for 37 years, count (June, 1980 - September, 2017)
Independent Variables	Long-term Average Monthly Temperature	Average monthly temperature for 37 years, degrees Celsius (June, 1980 - September, 2017); 12 values
	Temperature Anomaly	Difference of actual month's temperature from the 37-year monthly average, degrees Celsius (June, 1980 - September, 2017)
	Months	Categorical dummy variables. Predictor for the influence of each month. January = reference month.
	Year	Predictor for the influence of time
Canyonlands National Park Model		
Variables	Factor	Description
Dependant Variable	Canyonlands National Park Visitation	Monthly recorded park visitors for 38 years, count (January, 1979 - September, 2017)
Independent Variables	Long-term Average Monthly Temperature	Average monthly temperature for 38 years, degrees Celsius (January, 1979 - September, 2017); 12 values
	Temperature Anomaly	Difference of actual month's temperature from the 38-year monthly average, degrees Celsius (January, 1979 - September, 2017)
	Months	Categorical dummy variables. Predictor for the influence of each month. January = reference month.
	Year	Predictor for the influence of time.

To calculate the long-term average monthly temperature for each location, first the minimum and maximum monthly temperatures for each month from the time periods

available for each national park was averaged to create an average monthly temperature.

Then all the average monthly temperatures (minimum/maximum averages for each month) was averaged for the given month over the time period of the dataset to create the long-term average monthly temperature (Table 2). The minimum and maximum temperatures were averaged due to the high correlation between the variables, which had potential to skew the interpretation of results. The temperature anomaly was calculated by subtracting the monthly temperature from the long-term average monthly temperature of each month (Figures 7 and 8). The anomaly from the mean was included in the analysis to avoid stationarity that occurs when using a long-term mean. Anomalies allow for “more accurate descriptions over larger areas than actual [air] temperature” readings from a single weather station, and provide a frame of reference that is easier to analyze (Wheeling Jesuit University and NASA 2018). Monthly departures from the long-term monthly average (temperature anomalies) were used to understand the difference between expect temperature and the actual temperature.

Table 2. Long-term average monthly temperature

Month	Arches National Park (°C)	Canyonlands National Park (°C)
January	-0.475	2.631
February	3.813	1.573
March	9.460	6.503
April	13.485	10.461
May	18.852	15.970
June	25.116	22.630
July	28.605	25.830
August	27.110	24.365
September	21.988	19.646
October	14.309	12.341
November	6.559	4.527
December	0.430	-1.091

The long-term monthly average temperature displayed by each month for Arches National Park and Canyonlands National Park.

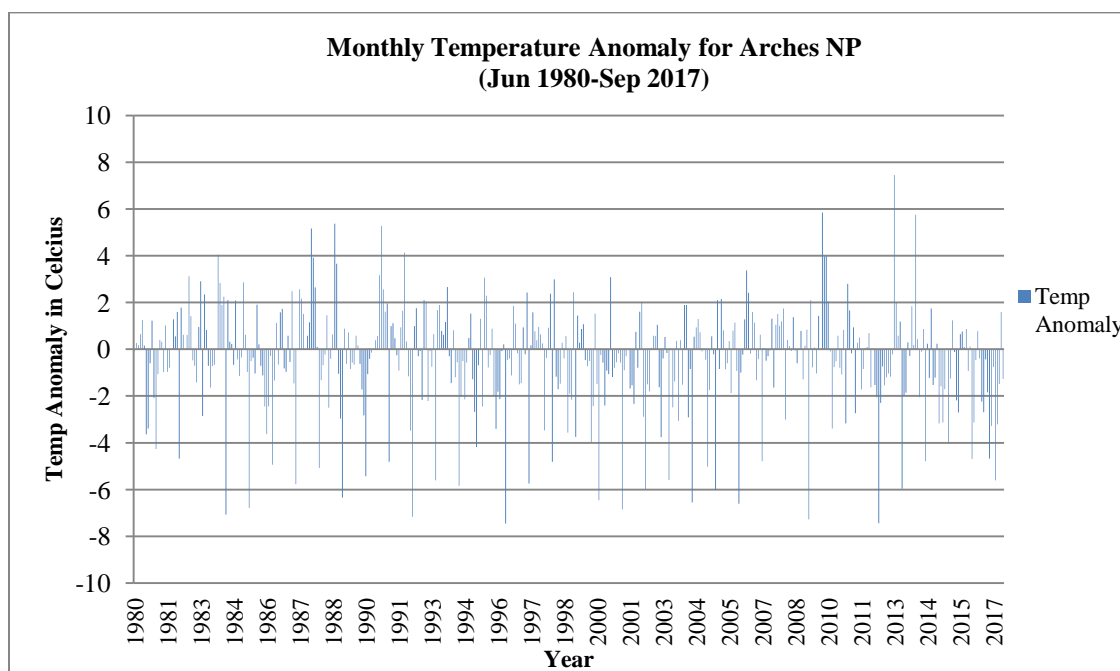


Figure 7. Temperature anomaly for Arches National Park. The monthly temperature anomaly displayed for Arches National Park from June 1980 to September 2017.

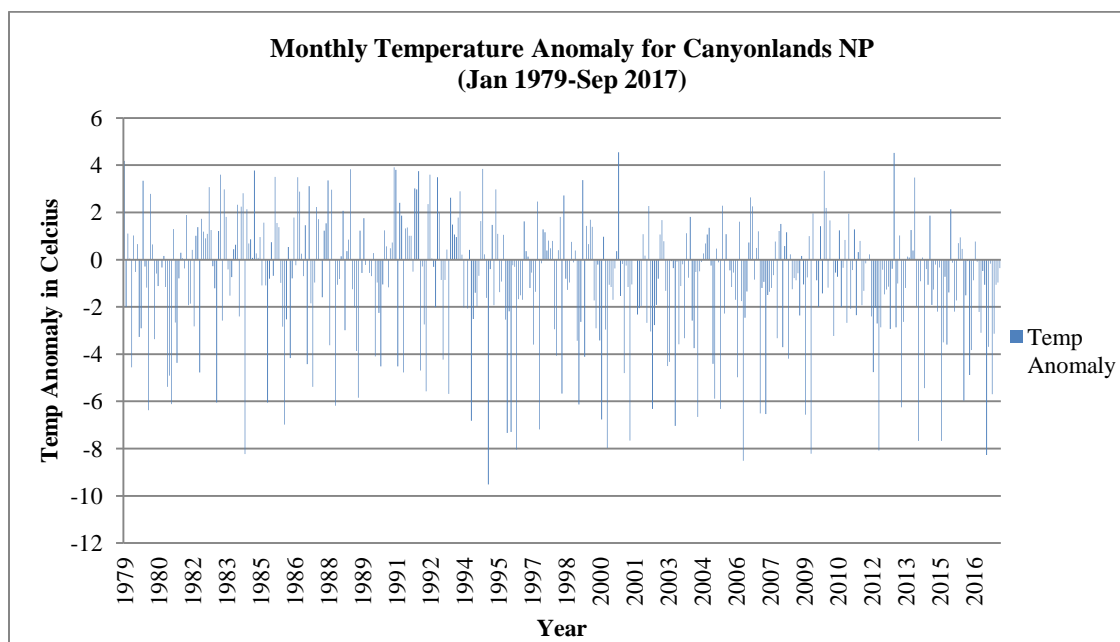


Figure 8. Temperature anomaly for Canyonlands National Park. The monthly temperature anomaly displayed for Canyonlands National Park from January 1979 to September 2017.

Additional predictor variables included year and months. The year variable accounts for a long-term trend in increasing visitation, while the month variable accounts for seasonal variation within the year. Months of the year were transformed into categorical dummy variables with January as the reference category. January was chosen as the reference category for each location since it was the month with the lowest average visitation in Arches National Park and Canyonlands National Park. The dependent variable, monthly visitation, was rescaled to visitation in thousands to allow for more direct interpretation of coefficients. The method of model entry for the predictor variables was hierarchical entry, in which predictors are entered into the model in a set order, so that random variation in the data does not influence the model (Field 2013). Hierarchical entry is utilized when variables have been analyzed in previous research and shown to

have an important relationship with the dependent variable. Air temperature variables were entered into the model first, followed by the monthly dummy variables, and finally the year.

The (primarily) qualitative data collected through the surveys was analyzed by coding data to categorize and organize data from the open-questions. For consistency, only the researcher was involved in the creation of the code book, the coding of survey data, and the analysis. Descriptive statistics were calculated for each closed-question to understand the frequency, mean, and standard deviation of responses. Closed-question survey data were analyzed using IBM SPSS.

Descriptive coding for key themes and broader patterns was used for the open-questions, where respondents were asked to write detailed responses (Table 3). Descriptive coding groups full or partial responses together based on obvious characteristics or themes that are stated directly by participants (Hay 2010). For example, responses that mentioned changes in winter rainfall were grouped together as changes in winter weather. The qualitative responses given in the survey were not simply coded into simple categories for statistical analysis, because the data cannot be directly generalized to all arid small communities that possess outdoor recreation and tourism (Table 3). Quantifying the qualitative open-question responses has the potential to lead to statistical misleading and a less complex understanding of meaning and social structures in the community (Hay 2010).

Table 3. Open response questions and coded themes and patterns

Question ^a	Coded themes and patterns from responses
Q7. What are the seasons for activities your business participates in throughout the year? Please explain the start and end times in terms of months.	Special events Busiest season Moderate season, steady business Shoulder season, season slows Open all year Water-based tourism season Land-based tourism season
Q8. Over time, has your business experienced a change in the start or end of certain seasons? If yes, please describe the change.	Change due to popularity of Moab, advertising Longer season, change in season, season extended No change, no Change in weather Change due to desire of owner and worker availability Visitation increase over time
Q9. If you have experienced changes to the start and/or end of certain seasons, to what do you attribute these changes?	Popularity of Moab, advertising Institutional reasons: political, economics, holidays, school Local development Environmental change in season - winter and spring No, not applicable Weather Worker availability, staffing, management decisions Visitation increase over time
Q11. Please describe the nature of the closures for selected months.	Full closure Partial closure of facilities Closure due to winter conditions, ice and snow, winter weather Closure due to low visitation Diversified trips, limited winter recreation options Closure due to institutional factors, contracts
Q15. Please describe the changes that you have experienced and how they have affected your business.	Weather (general) Change in winter Change in summer Weather events Economic change Little to no change Advertising Increase in business
Q16. How has visitation changed for your business, as environmental factors have changed during different seasons? Please indicate the timescale over which you have noticed these visitation changes, e.g., since 2007, or over the last 3 years.	No change, little change due to weather Higher visitation Change due to popularity, advertising Lower sales Weather (temperature and rainfall) Extended season City infrastructure (negative)

Q17. How concerned or worried are you about environmental factors influencing your business in the future?	<p>Not concerned</p> <p>Mildly concerned, somewhat worried, few worries</p> <p>Concerned, worried</p> <p>Adaptability, adaptive business, change business</p> <p>Other influences and concerns (non-environmental)</p>
Q18. Thinking about changes in visitation and/or environmental factors, are there adaptive strategies or plans the business is currently using? How has your business responded to changes in visitation and/or environmental factors throughout the year?	<p>No current plan, no change</p> <p>Hiring workers, start time for workers</p> <p>Plans with other businesses or institutions</p> <p>Start season earlier</p> <p>End season later</p> <p>End season earlier</p> <p>Business purchases, investments</p> <p>Higher quality of tours, more tours, diversity of tours</p> <p>Earlier start to day</p> <p>Marketing, social media</p> <p>Communicating with visitors</p>
Q 19. Thinking about changes in visitation and/or environmental factors, are there adaptive strategies or plans the business is considering using in the future?	<p>No future plan, no change</p> <p>Hiring workers, start time for workers</p> <p>Plans w/ other businesses or institutions</p> <p>Start season earlier</p> <p>End season later</p> <p>Business purchases, investments</p> <p>Higher quantity of tours, more tours, diversity of tours</p> <p>Communicating w/ visitors</p> <p>Retire</p>
Q20. Are there changes you would like to make to adapt to either changing environmental factors and conditions, or changing visitation, but cannot currently make? What are these changes and why can you not make them currently?	<p>No, no change</p> <p>Business purchases, investments</p> <p>Building infrastructure</p> <p>Housing Concerns Inhibiting change</p> <p>Political Concerns Inhibiting more visitation</p> <p>Over-Use Concerns Inhibiting change</p>
Q21. Aside from the information you have provided, is there anything else that you would like to tell us?	<p>Issues of impact on environment</p> <p>Drivers of visitation, popularity of Moab, beauty</p> <p>No influence on visitation or business from climate</p>

a. Coded open question responses to a survey that was distributed to outdoor recreation and tourism businesses in Moab, Utah. Listed are the coded themes and patterns that emerged in the responses.

RESULTS

Multivariate Linear Regression Model: Arches National Park

The predictors in the Arches National Park model included long-term average monthly temperature, temperature anomaly, year, February, March, April, May, June, August, September, October, November, and December (Table 4). The dummy variable representing July was removed from the Arches National Park model, because it had a low tolerance level (0.000), which is a sign for issues of multicollinearity. The low tolerance level indicated that July was almost a perfect linear combination of other independent variables already in the equation. The model summary shows that a high level of variability in the outcome is accounted for in the predictors with an R^2 of 0.872. The adjusted R^2 (0.868) is similar, indicating that the predictor variables are significant in the model.

Table 4. Coefficients for the Arches National Park model ^a

Model Variables ^b	Unstandardized		Standardized		t	Sig.	95.0% Confidence		Correlations			Collinearity ^c	
	Coefficients		Coefficients				Interval for B		Statistics				
	B	Std. Error	Beta				Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	-4435.833	163.002			-27.213	0.000	-4756.205	-4115.460					
Long-term Average Temperature	3.474	0.147	0.677		23.680	0.000	3.185	3.762	0.773	0.751	0.407	0.362	2.762
Temperature Anomaly	1.195	0.516	0.040		2.316	0.021	0.181	2.209	0.092	0.111	0.040	0.988	1.012
February	-10.888	4.015	-0.059		-2.712	0.007	-18.778	-2.997	-0.310	-0.129	-0.047	0.624	1.603
March	10.837	3.777	0.059		2.869	0.004	3.414	18.260	-0.065	0.137	0.049	0.705	1.419
April	17.880	3.712	0.097		4.816	0.000	10.584	25.177	0.059	0.226	0.083	0.729	1.371
May	31.363	3.771	0.170		8.316	0.000	23.951	38.776	0.249	0.371	0.143	0.707	1.415
June	11.244	4.008	0.062		2.806	0.005	3.367	19.121	0.256	0.134	0.048	0.611	1.637
August	5.369	4.133	0.029		1.299	0.195	-2.753	13.492	0.262	0.062	0.022	0.574	1.741
September	16.618	3.880	0.090		4.283	0.000	8.993	24.244	0.223	0.202	0.074	0.668	1.498
October	2.219	3.711	0.012		.598	0.550	-5.075	9.513	-0.030	0.029	0.010	0.730	1.370
November	-9.422	3.879	-0.051		-2.429	0.016	-17.046	-1.797	-0.258	-0.116	-0.042	0.668	1.497
December	0.749	4.230	0.004		.177	0.860	-7.565	9.062	-0.324	0.009	0.003	0.562	1.780
Year	2.225	0.082	0.473		27.290	0.000	2.065	2.385	0.480	0.795	0.469	0.987	1.014

a. Dependent variable: visitation for Arches National Park
b. July was removed from the model due to a low tolerance value which indicates issues of multicollinearity for that particular month.

The Arches National Park long-term average temperature variable's unstandardized b -value ($b = 3.474$) indicates that as the long-term average temperature increases by one unit, visitation to Arches National Park increases by 3.474 units. With Arches National Park visitation being measured in thousands, this model suggests that for every increase in 1°C , an additional 3474 people would be expected to visit Arches National Park, if the effects of the other predictor variables were held constant. When looking at the relationship between monthly visitation and long-term average temperature, spring, summer, and fall months with air temperature above 8°C have historically higher levels of visitation compared to colder winter months like January, December, and February (Figure 9). The temperature anomaly unstandardized b -value ($b = 1.195$) denotes that as the temperature anomaly increases by 1°C , visitation to Arches National Park increases by 1195 visitors, if the effects of the other predictors is held constant. The effect of the temperature anomaly on visitation is small, but is still statistically significant (standardized $\beta = 0.040$, $p < 0.05$). Examining the relationship between visitation and temperature anomaly indicates that visitation clusters between temperature anomalies of -4°C to 4°C (Figure 10). The long-term average temperature ($\beta = 0.677$, $p < 0.001$) and the temperature anomaly ($\beta = 0.040$, $p < 0.05$) are both significant with positive standardized β -values, which indicates that the expected and the actual temperature of a month are positively influencing visitation to Arches National Park.

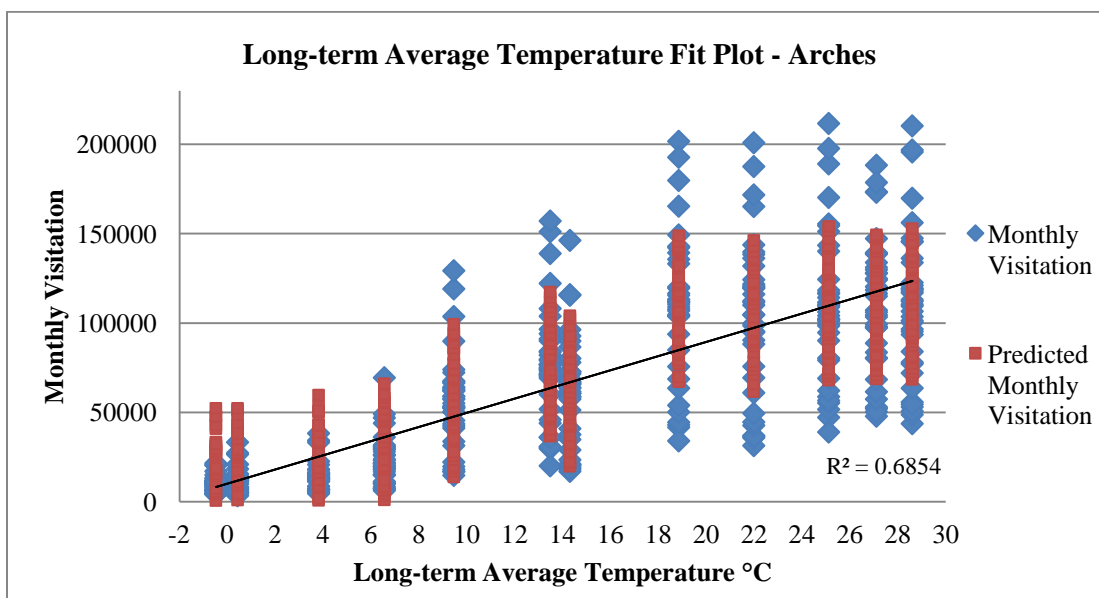


Figure 9. Long-term average temperature and visitation fit plot - Arches. Displaying visitation relative to average monthly temperature with a fitted linear regression line and R^2 0.685.

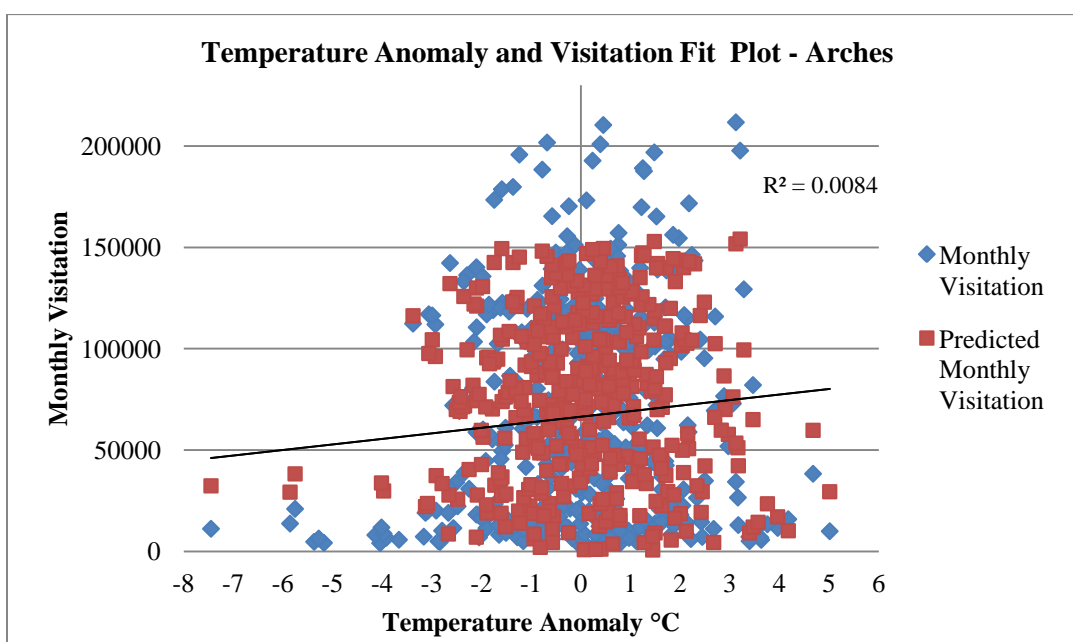


Figure 10. Temperature anomaly and visitation fit plot - Arches. Displaying visitation relative to temperature anomaly with a fitted linear regression line and R^2 0.008.

The year b -value ($b = 2.225$) indicates that with each additional year, visitation to Arches National Park will grow by 2225 visitors, if the effect of the other predictors hold constant (Figure 11). With the largest standardized coefficient value for the long-term average temperature variable ($\beta = 0.677$) and a small p -value ($p < 0.001$), the long-term average temperature makes the greatest contribution to the model. The year also makes a substantial contribution to the model with a small p -value ($p < 0.001$) and a large β -statistic ($\beta = 0.473$), so it is positively influencing visitation to Arches National Park. None of the statistically significant monthly variables make as large of a contribution to the model.

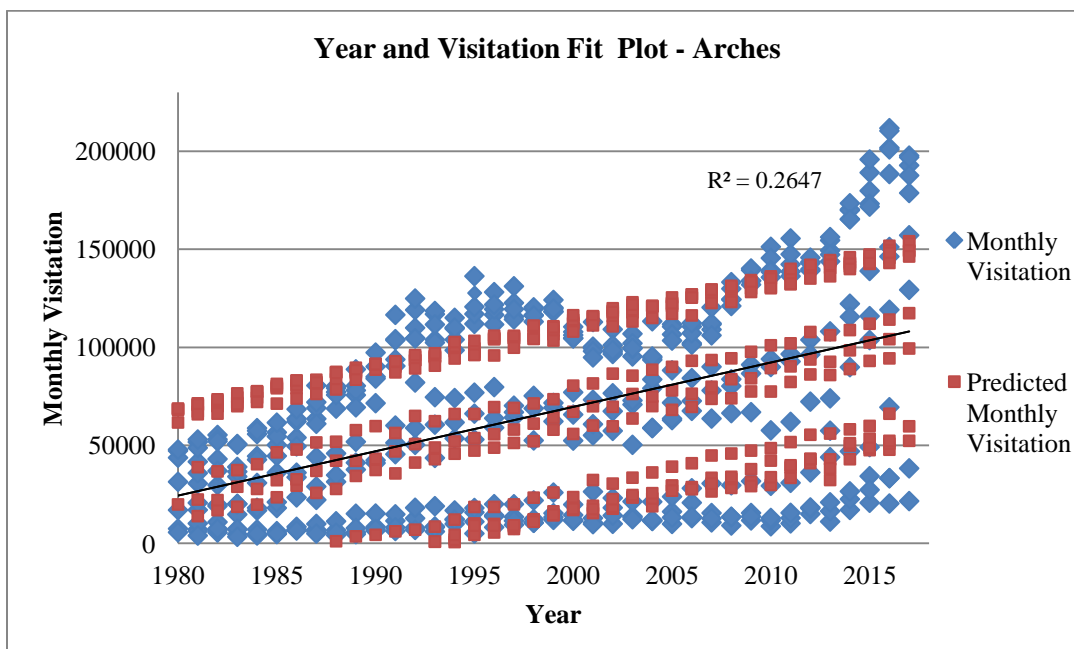


Figure 11. Year and visitation fit plot – Arches. Displaying visitation relative to year with a fitted linear regression line and R^2 0.265

Comparing the monthly variables to January reveals that seven months are significantly different from January and have considerable unstandardized b -values: February ($b = -10.888$), March ($b = 10.837$), April ($b = 17.880$), May ($b = 31.363$), June ($b = 11.244$), September ($b = 16.618$), and November ($b = -9.422$). March through June, September, and November would be expected to have high levels of visitation for Arches. August, October, and December are not significantly different from January according to their very low unstandardized b -values and high p -values. Comparing the months to each other, May is the most different from January with a very high b -value ($b = 31.363$). This indicates that visitation is expected to be the highest for May with 31,363 more visitors during this month, if all other variables are held constant. February ($b = -10.888$, $p < 0.01$) and November ($b = -9.422$, $p < 0.05$) are the only months that are negatively different from January, which could indicate that visitation is lower than expected during those months.

Multivariate Linear Regression Model: Canyonlands National Park

The predictors in the Canyonlands National Park model included temperature anomaly, long-term average temperature, year, and the months of March, April, May, June, August, September, October, November, December (Table 5). The dummy variable representing July was also removed from the Canyonlands National Park model, because it has a low tolerance level (0.000) which indicates issues of multicollinearity for that particular variable. The model summary shows that a high level of variability in the outcome is accounted for by the predictors, with an R^2 of 0.797. The adjusted R^2

(0.791) is similar, indicating that the predictor variables are significant in the model. The b -values show a positive relationship between visitation to Canyonlands National Park and significant predictor variables ($p < 0.005$). The temperature anomaly and February are not significant predictor variables for visitation to Canyonlands National Park.

The b -value for long-term average temperature at Canyonlands National Park ($b = 1.540$) indicates that as long-term average temperature increases by one unit, visitation to Canyonlands National Park increases by 1.540 units. Visitation is measured in thousands, therefore, this model suggests that for every increase in 1°C , an additional 1540 people visit Canyonlands National Park, if the effects of the other predictor variables hold constant. The year b -value ($b = 1.118$) indicates that as the year increases by one unit, visitation to Canyonlands National Park increases by 1.118 units, which means that each additional year is associated with 1118 additional visitors to Canyonlands National Park, if the effects of the other predictors are held constant.

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Table 5. Coefficients for Canyonlands National Park model. ^a

Model Variables ^b	Unstandardized Coefficients		Standardized Coefficients		t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics
	B	Std. Error	Beta				Lower Bound	Upper Bound	Zero-order	Partial	Part	VIF
(Constant)	-2234.917	95.348			-23.439		-2422.301	-2047.533				
Long-term Average Temperature	1.540	0.111	0.567		13.924	0.000	1.322	1.757	0.605	0.549	0.296	0.273
												3.667
Temperature Anomaly	0.380	0.291	0.028		1.305	0.193	-0.192	0.953	0.132	0.061	0.028	0.959
												1.043
February	3.385	2.625	0.038		1.290	0.198	-1.773	8.544	-0.298	0.061	0.027	0.527
												1.898
March	16.145	2.365	0.182		6.826	0.000	11.497	20.793	-0.052	0.307	0.145	0.634
												1.578
April	26.867	2.248	0.303		11.954	0.000	22.450	31.285	0.155	0.491	0.254	0.702
												1.425
May	31.206	2.222	0.352		14.046	0.000	26.840	35.572	0.313	0.553	0.299	0.718
												1.392
June	8.819	2.405	0.100		3.666	0.000	4.092	13.546	0.163	0.170	0.078	0.613
												1.632
August	4.133	2.487	0.047		1.662	0.097	-0.754	9.021	0.139	0.078	0.035	0.573
												1.744
September	18.405	2.296	0.208		8.017	0.000	13.893	22.917	0.225	0.354	0.170	0.673
												1.486
October	19.430	2.239	0.217		8.677	0.000	15.029	23.831	0.091	0.379	0.185	0.724
												1.381
November	6.073	2.468	0.068		2.460	0.014	1.222	10.924	-0.218	0.115	0.052	0.596
												1.678
December	7.169	2.791	0.080		2.568	0.011	1.683	12.655	-0.310	0.120	0.055	0.466
												2.146
Year	1.118	0.048	0.509		23.440	0.000	1.025	1.212	0.519	0.742	0.498	0.958
												1.043

a. Dependent Variable: Canyonlands National Park Visitation

b. July was removed from the model due to having a low tolerance value which indicates issues of multicollinearity with the variable

The large standardized coefficient value for the long-term average temperature variable ($\beta = 0.567$) and small significance value ($p < 0.001$) signifies that the long-term average temperature is making the greatest contribution to the model. Year, May, and April also make a considerable contribution to the model with small significance values ($p < 0.001$), and large β -values: year, $\beta = 0.509$, May, $\beta = 0.352$, and April, $\beta = 0.303$. The temperature anomaly is not making a significant contribution to the model, while the long-term average temperature is significant ($p < 0.001$), which can indicate that visitors to Canyonlands National Park are planning their trip based on historical trends in temperature for that month. The relationship between monthly visitation and long-term average temperature also indicates that spring, summer, and fall months with air temperature above 10°C have historically higher levels of visitation compared to winter months (Figure 12). Even though the temperature anomaly is not making a significant contribution to the model (it is not heavily influencing visitation), the majority of visitation clusters between a temperature anomaly of -4°C and 4°C for Canyonlands National Park, the same as Arches National Park (Figure 13).

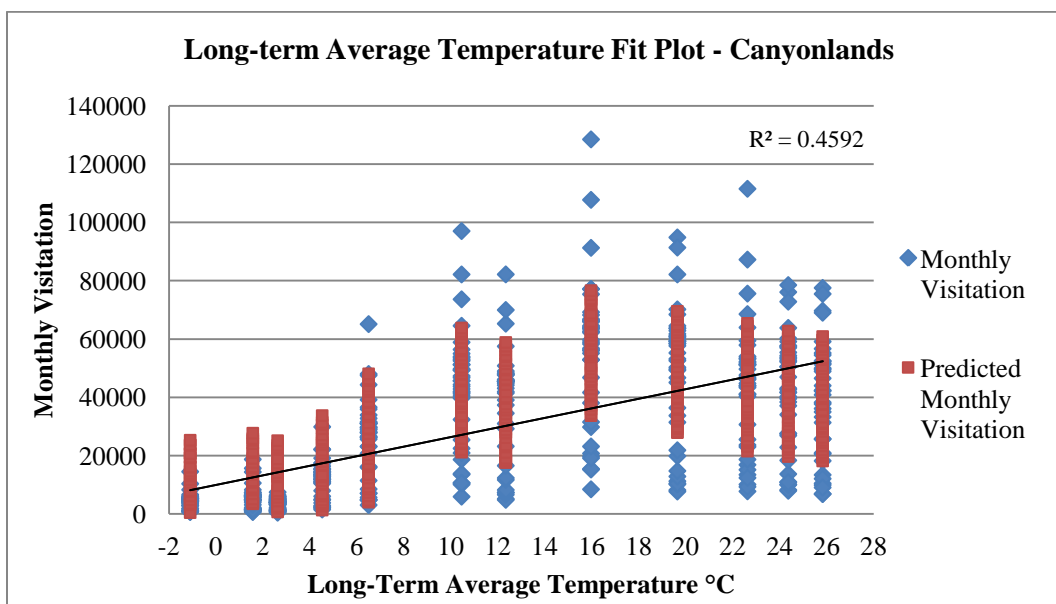


Figure 12. Long-term average temperature and visitation – Canyonlands. Displaying visitation relative to average monthly temperature with a linear regression line and R^2 0.459.

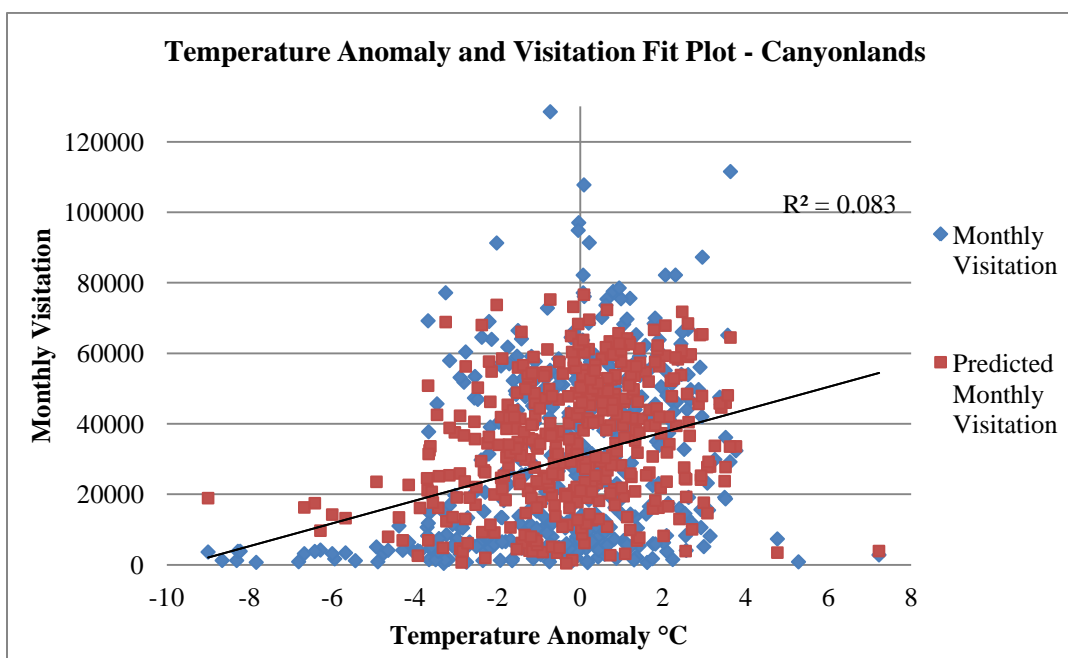


Figure 13. Temperature anomaly and visitation fit plot – Canyonlands. Displaying visitation relative to temperature anomaly with a linear regression line and R^2 0.083.

Looking at the monthly dummy variables, January is the reference month with the lowest visitation average. Eight of the 10 months are significantly different from January in the model and have considerable unstandardized B-values: March ($b = 16.145$), April ($b = 26.867$), May ($b = 31.206$), June ($b = 8.819$), September ($b = 18.405$), and October ($b = 19.430$). In terms of seasonal visitation, it is expected that March through June, September, and October would have some of the highest levels of visitation to Canyonlands National Park. February and August are not significantly different from January according to the model's very low unstandardized b -values and high p -values. As seen with May for Arches National Park, May is the most different from January, with a high unstandardized b -value ($b = 31.206$) signifying that visitation is expected to be highest in May.

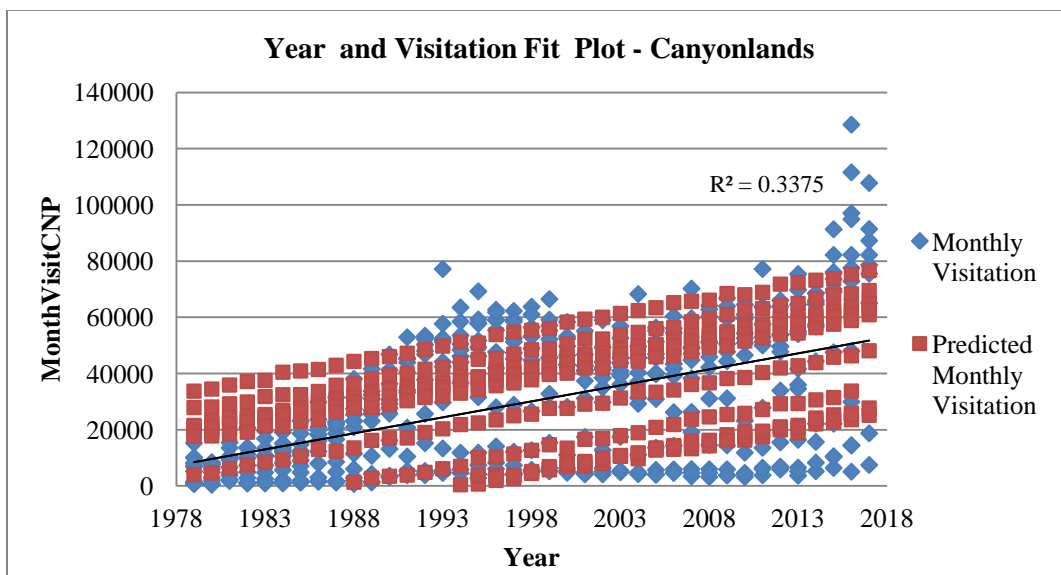


Figure 14. Year and visitation fit plot – Canyonlands. Displaying visitation relative to year with a linear regression line and R^2 0.338.

Confounding Variables and Correlation in Models

The potential confounding factors within the results are that visitation is increasing independently of increasing air temperature due, for example, to funding spent on tourism and recreation advertising. The effects of potential confounding variables were minimized by including the covariates of the year and months in the multivariate linear regression. Data on funding spent on tourism and recreation advertising for Arches and Canyonlands was not as accessible, so it was not directly included. Instead the year variable was used as a means to capture the relationship advertising and popularity of the region have with visitation. The year represents historical trends in visitation and change over time driven by other additional factors, which could include area popularity and advertising. The models controlled for additional seasonal variations thru the month variables, capturing the effects of regular holidays, etcetera.

Outdoor Recreation and Tourism Industry Survey Results

From the twenty-two completed surveys, the types of tourism and recreation activities offered ranged from guided trips and tours, self-guided trips, water tours, aerial tours, land tours, mountain biking tours, photography tours, hiking tours, educational tours, horseback riding, and equipment rentals. Businesses were separated by type of tourism or recreation, as a way to understand if the type of activities offered influenced perceptions of climate change. Businesses were placed into five categories: water, aerial, land, other, and combination (Figure 15). Water tours included rafting, canoeing, kayaking, and jet boat tours. Aerial tours included hot air balloons, plane rides, helicopter

rides, and sky diving. Land tours were categorized as activities predominantly on land such as hiking, mountain biking, canyoneering, zip-lining, vehicle or off-roading tours (e.g., Jeep, ATV), horseback riding, and photography tours. Other businesses included gear rentals, vehicle rentals (e.g., Jeep and dirt bike rentals), water craft rentals, or other types of equipment rentals without a guide or tour component. A business was categorized as a combination if they offered two or more of the other categories in one trip as a main part of their services (e.g., water rafting with a planned Jeep tour). Businesses that offered land tours were the majority of respondents in this study with nine responses (Figure 15).

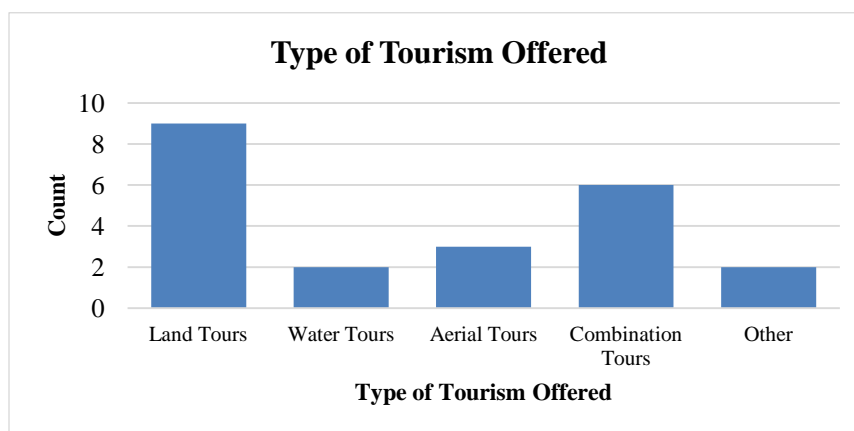


Figure 15. Types of tourism offered by recreation and tourism businesses in Moab, Utah. Land tours were the predominant type of tourism and recreation activity offered.

To understand the months businesses are suspending activities, participants were asked “If you close your business or suspend activities, during which months (include partial months) of the year do you typically close?” Of the twenty-two responses, five businesses operated year round and did not regularly close their business during any part

of the year, and one business did not respond to this question (Figure 16). Looking at the sixteen businesses that close or suspend recreation activities, November, December, January, and February were the months businesses closed or discontinued some of their activities and services (Figure 16). These four months were noted in open-questions by respondents as “too cold and wet” during the winter with “little business” and less tourism. Cold winter temperatures, snow, and winter weather were attributed as a large reason for full or partial closures. When comparing operators’ responses to the long-term monthly average temperatures for Arches and Canyonlands, November through February are on average the months with the lowest temperatures between -1.1°C to 6.5°C (Table 2). Many respondents whose businesses only partially closed or limited activities noted that they continue to retain some employees during these months to take reservations, sell trips, monitor websites and phone lines, and “attend to administrative duties” while they are closed to the public.

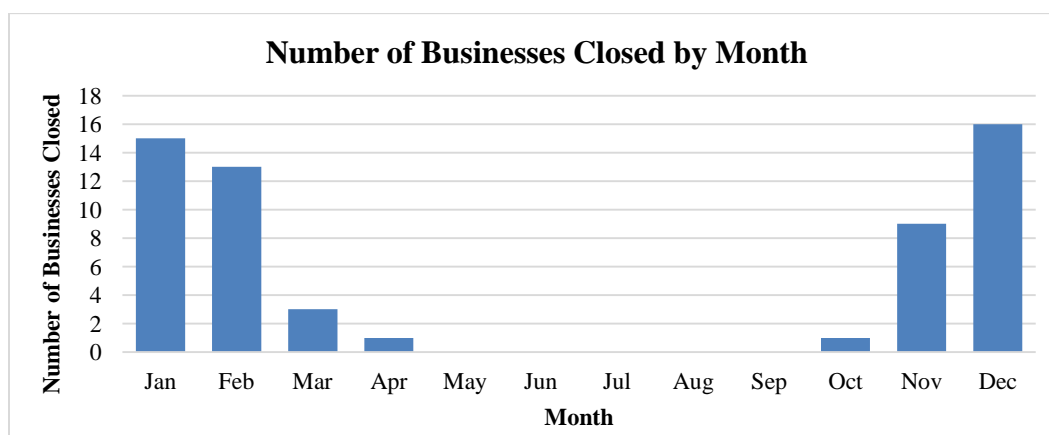


Figure 16. Number of businesses closed by month in Moab, Utah. 16 businesses close or suspend services during some months. The majority of businesses close from November to February. The 5 businesses that operate all year are not included here.

When asked, “What are the seasons for activities your business participates in throughout the year? Please explain the start and end times in terms of months,” respondents wrote that March to April was the start of the busy season, spring months. Responses indicate that the end of March through October is the main time frame that recreation and tourism activities are operating. Some of the busiest times for various types of businesses within this period included March to May with Spring Break (a student vacation in mid-March) and September to October. Businesses specializing in water tours had varying start times between March and May, and ended their water tour season in October, while businesses specializing in land tours started their season end of Feb to March, and ended their season between October and November. Of the businesses that operated all or most of their services year round, they specialized in land tours, aerial tours, or outdoor gear rentals. The operator’s responses indicate that their season for recreation and tourism visitation was predominantly from March to October, spring through fall.

In response to “Over time, has your business experienced a change in the start or end of certain seasons?,” the large majority of responses noted a longer season or no change to their seasons. The businesses that did not experience change mentioned a history of always closing during specific months. Four businesses also noted that unpredictable weather potentially altered start/end times. One response expressed that “some of this [change] is weather dependent and the ski industry can affect business. A good early start to ski can slow the activity in Moab.” When asked what they attributed

changes in the start or end of seasons to, the biggest contributors are believed to be the popularity of Moab and advertising:

“Popularity of Moab as a destination and visibility and reputation of our company has increased our Day Tours and extended the season.”

“Moab’s popularity undoubtedly has the largest impact on this. As the state continues to pour millions into advertising both National Parks in Southern Utah and general tourism advertising, we are seeing a sharp increase in visitation.”

“[We] used to operate the rafting tours from May through August, but as Moab grew as a destination and demand for our trips grew, we expanded to our current March through October season.”

“Moab is a busy destination. If people want to visit Arches and Canyonlands National Parks and other area destinations, they need to come when it’s not so crowded.”

Another significant contributor noted was changes in the winter and spring months.

Warmer winter temperatures and an earlier start to spring are believed to have “increased the shoulder season” and encouraged tourism in the desert.

Participants were asked a series of scaled questions about the perceived effect environmental factors and conditions have on their businesses (Table 6). The responses highlight the perception that generally warm temperatures have a very positive (50%) influence, while very high temperatures have a negative effect (60%) on businesses. Generally cold temperatures were viewed as having no effect (45%) or a negative effect (30%), while very low temperatures have a negative (65%) or very negative (25%) influence. In relation to winter months, this relates back to the reasons why businesses closed during November, December, January, and February. These months are well documented as having very low temperatures. Aside from temperature, the majority of

responses indicate that businesses perceive decreased and unpredictable rainfall, low and unpredictable water levels, and snowpack as having no effect. High water levels and river flow were believed to have a positive effect by 31.6 percent of businesses, which lines up with some of the open-question responses from businesses that participate in water tours: “the amount of snowpack and rainfall directly correlate to certain stretches of rivers we can run.” Increased yearly rainfall had a mixed response ranging from negative (27.3%), no effect (36.4%) to positive (18.2%).

Table 6. Survey Responses ^a

Table 6: Survey Responses									
Question	Factors or Conditions	Scaled Responses					Total	Mean	SD
		Very Negative	Negative	No Effect	Positive	Very Positive			
Q12. How would you characterize the effect on your business of the following environmental factors or conditions?	Generally Warm Temperatures	0 (0%)	0 (0%)	4 (20%)	6 (30%)	10 (50%)	20	1.70	0.801
	Generally Cold Temperatures	2 (10%)	6 (30%)	9 (45%)	3 (15%)	0 (0%)	20	3.35	0.875
	Very High Temperatures	1 (5%)	12 (60%)	4 (20%)	2 (10%)	1 (5%)	20	3.50	0.946
	Very Low Temperatures	5 (25%)	13 (65%)	2 (10%)	0 (0%)	0 (0%)	20	4.15	0.587
	Unpredictable Temperatures	0 (0%)	7 (35%)	12 (60%)	1 (5%)	0 (0%)	20	3.30	0.571
	High Water Levels and River Flow	0 (0%)	2 (10.5%)	9 (47.4%)	6 (31.6%)	2 (9.1%)	19	2.58	0.838
	Low Water Levels and River Flows	0 (0%)	3 (15.8%)	14 (73.7%)	2 (10.5%)	0 (0%)	19	3.05	0.524
	Unpredictable Water Levels and River Flow	0 (0%)	3 (15.8%)	15 (78.9%)	1 (5.3%)	0 (0%)	19	3.11	0.459
	Increased Yearly Rainfall	1 (5.3%)	6 (27.3%)	8 (36.4%)	4 (18.2%)	0 (0%)	19	3.21	0.855
	Decreased Yearly Rainfall	0 (0%)	2 (10.5%)	11 (57.9%)	6 (31.6%)	0 (0%)	19	2.79	0.631
	Unpredictable Rainfall	0 (0%)	3 (17.6%)	13 (76.5%)	1 (5.9%)	0 (0%)	17	3.12	0.485
	Increased Snow Pack	1 (5.3%)	3 (15.8%)	10 (52.5%)	3 (15.8%)	2 (10.5%)	19	2.89	0.994
	Decreased Snow Pack	0 (0%)	1 (5.3%)	16 (84.2%)	1 (5.3%)	1 (5.3%)	19	2.89	0.567
Question	Business Aspects	Scaled Responses					Total	Mean	SD
		Large Increase	Increase	No Effect	Decrease	Large Decrease			
Q13. How have the following aspects of your business been impacted by changes to temperature, rainfall, water levels, or snow pack?	Employment	0 (0%)	1 (5%)	19 (95%)	0 (0%)	0 (0%)	20	2.95	0.224
	Sales	0 (0%)	4 (20%)	15 (75%)	1 (5%)	0 (0%)	20	2.85	0.489
	Operating Costs	0 (0%)	5 (25%)	14 (70%)	1 (5%)	0 (0%)	20	2.80	0.523
	Profits	0 (0%)	4 (20%)	14 (70%)	2 (10%)	0 (0%)	20	2.90	0.553
	Seasons for Activities	0 (0%)	6 (30%)	12 (60%)	2 (10%)	0 (0%)	20	2.80	0.616
	Type of Activities Offered	0 (0%)	3 (15%)	16 (80%)	1 (5%)	0 (0%)	20	2.90	0.447
	Visitation	0 (0%)	3 (15.8%)	14 (73.7%)	2 (10.5%)	0 (0%)	19	2.95	0.524
Question		Scaled Responses					Total	Mean	SD
		None at all	A little	A moderate amount	A lot	A great deal			
Q14. Changes in climate can include shifts in rainfall, snowfall, and temperature. Based on your own experiences, how much have changes in climate affected your business?		6 (31.6%)	9 (47.4%)	4 (21.2%)	0 (0%)	0 (0%)	19	4.11	0.737

a. Questions examined perceptions on how environmental factors and conditions have affected businesses in Moab, Utah

To understand how aspects of the business were impacted by changes to temperature, rainfall, water levels, or snow pack, participants were asked to rate the impact to employment, sales, operating costs, profits, seasons for activities, type of activities offered, and visitation (Table 6). The majority of participants indicated that there was no effect to employment (95%), sales (75%), operating costs (70%), types of activities offered (80%), and visitation (73.4%). With regard to seasons for activities, 60 percent responded no effect, while 30 percent responded that there was an increase in the seasons for activities due to changes in environmental factors and climate (Table 6). The ranked responses contrast with some of the previous written responses that noted how warmer winters and a longer season are influencing businesses. There is potentially a disconnect or a noted dual perception between how businesses believe aspects of their operations are influenced by changes in environmental factors and climate, and what changes they are perceiving in their environment. The responses to “how much have changes in climate affected your business?” are more similar to written responses on how certain seasons have changed with 47.4 percent believing changes in climate have affected their business a little and 21.2 percent a moderate amount.

In open-questions, participants elaborated on the changes in climate they experienced and how these changes affected their businesses. Temperature was mentioned by five participants as a large influence on the numbers of people booking tours, and the business’s ability to run trips. “When the temps are over 100 for days at a time people seem less likely to visit Moab or plan outdoor activities.” A business that conducts land tours stated, “We cannot run our full day tours when it’s over 95°F for

safety reasons.” Temperature being too hot or too cold was noted as driving tourists away from land and aerial tours, which aligns with the Likert scale responses with very high and very low temperatures as having a negative impact on business. Summer tourism may decrease for certain activities or times of day due to temperature, but for some visitors, summer is the only time for vacation. “July and August can slow down on active recreation visitors due to the heat but seems to be more than offset by just car travel, sight-seeing recreation by those who have to take vacation in the summer and they do things avoiding the hottest part of the day.” However, during winters with warmer temperatures, some businesses have the opportunity to “do more business in February and November.” Temperature was selected for the regression models, because in exploratory analysis it was shown to have a statistically significant relationship with visitation to the national parks.

Precipitation in the form of snowfall and rainfall were commented on by water tour companies as having a direct correlation to “certain stretches of rivers [available to] run”: “When there is an increased snow pack the rivers have more water and guests are provided with more white water opportunity.” For some businesses providing land tours, having less precipitation “means more business” and less cancelations due to weather. Heavy precipitation events such as summer flooding can also be economically detrimental because they can wash away off-road trails and require businesses to reinvest in rebuilding the roads and hire external maintenance workers. However, businesses that offer ‘wet canyon’ land tours, benefit from precipitation in the form of rain throughout the year. Heavy precipitation, mainly in the form of snow during winter, can leave other

seasons with little to no water in the canyons for ‘wet canyon’ tours. Precipitation as a variable was not included in the models because exploratory analysis of the climate data indicated no statistically significant relationship between precipitation and visitation to the national parks.

The few businesses that viewed changes in climate as having little or no influence on their business commented, “we have encountered various challenges due to weather but not more than we have ever seen... so we just deal with them as they come along,” “we just deal with the extra wind, etc. as it happens.” Some participants noted that because their business deals in outdoor recreation, they expect weather to not be predictable and so they have always tried to prepare for the unpredictable:

“I am not a climate change denier. I work in an outdoor business outdoors. Hot, cold, wet, dry, high water, low water are business realities for me no matter what the cause of these changes are perceived to be... Variability is elemental to all aspects of my business. I don’t expect predictability in what I do and to an extent neither do my clients.”

To clarify how visitation potentially changed through time with regard to changing environmental factors, participants were asked, “How has visitation changed for your business, as environmental factors have changed during different seasons?” The majority of responses included themes of little or no change due to environmental factors, and higher visitation in the last five to ten years that has little relationship with environmental factors or weather. Higher visitation is instead associated with a history of increasing popularity of Moab, the increasing popularity of outdoor recreation activities, a growing tourism economy in Utah, and successful advertising campaigns by individual companies and the state of Utah.

“I believe the increase is not due so much to environmental factors as to advertising: The Big 5.” (Referring to The Mighty 5, the Utah Office of Tourism’s National Park advertising campaign. The “Mighty 5” are Arches National Park, Bryce Canyon National Park, Canyonlands National Park, Capitol Reef National Park, and Zion National Park).

“Our trail systems have gotten a lot of press and some of our trips are more popular.”

“Visitation in the Moab, Utah area has increased steadily. Visitation to the state has also increased to a slightly lesser degree.”

“We have not noticed any significant changes in our visitation due to climate changes.”

“This summer (2017) we had one of the hottest and driest years on record, but because our tourism market continues to grow in town, we did not experience any decline in [visitor] numbers.”

“The increase in visitation has been going on for quite some time. We have seen increases since 1998 although the real change has been going on since 2010. With each passing year visitation records have been broken.”

Visitors were noted to book their trips early in “advance of localized weather issues,” which could partially explain an increase in visitation regardless of environmental factors or weather.

These responses demonstrate that the participants who have seen changes in visitation due to changes in environmental factors still expressed that the majority of change in visitation was due to the popularity of Moab and overall increases in tourism. This tendency was exhibited despite the responses on changes in visitation that signaled how “the spring and fall seasons have extended,” which has created opportunities for increases in businesses, or how warmer weather in recent years from “late October to November” has resulted in more visitation. Participants acknowledged that changes in the

environment do influence visitation and their businesses in the Likert questions, but in open-questions they expressed the ideas that environmental factors and climate change are not the major influence on fluctuations in visitation.

Not all increases or changes in visitation were described as upward or as good, due to a changing political atmosphere and a lack in adequate infrastructure. Foreign visitation was highlighted as having an “18 percent decrease... this year” due to certain political events within the last few years. The U.S. government shutdown in 2013 and a change in federal governmental administration were viewed as contributors to a decrease in foreign visitation and a loss in revenue. With increasing visitation, some participants expressed concerns about the infrastructure stress the area is increasingly experiencing. A few participants explained that increases in visitation are not always good or positive for tourism communities.

“The last five years have been incredible and have stretched resources almost to the breaking point. Many hotels have been built. New bike trails designed. More tour companies have moved in. The infrastructure has not kept up. Affordable housing is a major issue. Water treatment has long been ignored. Roads have not been maintained adequately. Our recycle center is overloaded and short of budget. Law enforcement is having difficulty keeping up and citizens’ quality of life is in question.”

“I have noticed the visitation changes over the past four years... The town changes incrementally with each year that passes. There are new hotels built every year, which has a significant impact on a small town (under 10,000 people). In 2015 Arches NP closed its gates due to traffic - the first such closure the park had ever experienced.”

When answering, “how concerned or worried are you about environmental factors influencing your business in the future?” as an open-question, seventeen of twenty participants reported mild to no concern. Participants who were not concerned or worried

remarked on how they are “able to run [their] tours in most conditions other than high winds, lightning, or ice/snow pack.” Responses noted how the tourism market continues to grow in Moab, and seasons (spring, summer, and start of fall) where the majority of revenue is generated have been consistent: “The tourism market has grown exponentially each year, despite the hotter, drier summers. Folks will still be looking for things to do outside of the national parks, and we will be there.” For participants who reported mild concern, they acknowledged that outdoor recreation is inherently “weather dependent..., conditions have to be favorable... for customers and staff to safely enjoy the experience.” Water access and dependence in terms of snowpack and health risks was a main environmental concern for all types of businesses.

“If rivers run low a number of years in a row, or heat-related deaths increase with the associated bad press, this would negatively affect outdoor tourism in Southeastern Utah.”

“A lack of snowpack would be very detrimental to our river programs.”

“My only concern here is the threat to Moab aquifers that we will face down the road due to a decrease in the snow pack that recharges our water supply.”

Other influences on businesses that instead concerned or worried participants were environmental degradation due to overuse, current U.S. politics, and shifting recreation preferences. Concern for overuse and the connection between the health of the environment and outdoor recreation was noted by two participants: “We are all affected by environmental factors. The desert is a fragile ecosystem that can’t absorb so many footsteps. It’s a delicate balance between growth and financial rewards versus destroying the very beauty that brings us all here.” The concept of environmental over-use by

humans was a subject for concern for all types of businesses: “Quite honestly Moab has much bigger problems than weather in my opinion. Over-visitation will be the death of this place long before the weather kills it.” Since various businesses attract foreign visitors and require permits to conduct business on public land, there is some worry about “the political climate and government control.” Additionally, the popularity of one type of recreation over another is a higher concern for some businesses that do not offer diverse types of tours.

Throughout the responses on level of concern or worry, the theme of adaptability and flexibility to changes in climate, weather, and environmental factors was very strong, especially among participants with mild or no concern. Participants commented on the ability of their business to offer different trips to circumvent weather changes and open during warm ‘shoulder seasons’. The theme of flexibility was emphasized, “deal[ing] with whatever happens” and “constantly diversifying and instituting internal changes in anticipation of trends.” The open-questions that followed asked about current adaptive practices, future adaptation plans, and finally, barriers to adaptation.

Adaptations and Barriers in Survey Results

“Thinking about changes in visitation and/or environmental factors, are there adaptive strategies or plans the business is currently using? How has your business responded to changes in visitation and/or environmental factors throughout the year?” Current adaptive plans and strategies to address changes in visitation and environmental factors varied heavily from no change in business practices, to changing seasons and hours for activities, increasing investments (purchasing recreation equipment, vehicles,

and offered rental equipment; expanding building space), diversifying, and communicating with guests. With comments of no change or no plan to change, participants indicated how positive the increase in visitation has been for business and how their businesses have always possessed a high level of flexibility. They are flexible to accommodate visitor schedules and anticipated environmental factors.

“No real changes since we are driven by our customer’s travel schedules.”

“Environmental- the changes are not drastic or significant enough that we can’t adjust simply our scheduling throughout the day on a day to day basis.”

“We have always had to potentially change a route if roads get wet so there really isn’t any change for us.”

Current adaptive strategies regarding changing seasons and hours for activities did not have a consistent pattern related to type of business or type of plan. Participants noted preparing the “business earlier in the year... as well as later into the fall season” than previously, and “starting tours as early as 5am to beat the heat of summer.” They attempt to schedule earlier travel to “avoid [the] hottest part of the day.” Changes in seasons and hours of activities were linked to employment and staffing needs. Employees are hired and “ready to go a few weeks earlier than we used to.” Several businesses noted an increase in number of staff to accommodate having to open earlier or close later in the year, while a few water tour businesses “had to close early due to not being able to hire enough people.” Hiring employees was a noted difficulty for some due to a lack of available or affordable housing. Participants also linked increasing staff members to increasing visitation: “hir[ing] more guides and retail workers to keep up with the

increase in visitors.” Increasing investments and offering more or diverse types of tours is another adaptation plan that all types of businesses used to capitalize on increased visitation growth. Businesses are purchasing new equipment and gear for additional tours or types of activities, and then hiring more employees as tour guides and staff.

A major adaptation strategy for increasing visitation that operators continuously expressed throughout the survey was marketing and communicating with visitors to increase visitation and to a lesser degree prepare visitors for a desert climate. Communication and marketing included “social media to reach potential clients,” advertisements from the local travel council and state level tourism office, and educating and preparing visitors for outdoor recreation. With consideration to environmental factors, visitors are prepared for changes in weather through employee explanations on “how and what to wear, pack, and gear” to use. “Because it is hot in Moab in the summer (always has been) and there is an increased awareness of the effects of dehydration, we now give all of our guests water bottles.” Businesses may also suggest different types of tours or alternative times to bypass hot temperatures.

When asked about possible future adaptive strategies or plans to handle changes in visitation or environmental factors, half the participants do not have future plans to change strategies or even have a plan for the future. The types of adaptive strategies that participants mentioned as future possibilities closely resembled what businesses are already using: more investments (recreation equipment, vehicles, expanding building space, offered rental equipment), expanding the business as visitation increases, and maintaining growth. In terms of future plans, there was more focus on adapting to

concerns around higher visitation instead of environmental change. Businesses offering water tours mentioned investments the most to keep pace with increases in visitation.

There is interest in potentially “purchas[ing] some kind of housing for guides and retail workers” to address housing concerns. Adaptive investment plans businesses are in the process of implementing include remodeling the store, buying additional equipment, and building on to current facilities.

There was little mention of adaptations to address future changes in environmental factors except preservation efforts and possibly staying open all winter. One perspective viewed “changes in weather [as something they] cannot address through a business plan.” Another participant explained how they plan to continue to “try to support groups that maintain and preserve [the desert, and] try to have a voice in regulation and preservation.” Future changes in environmental factors and climate change are not viewed as barriers to the growth of tourism even if the summers become hotter. Adaptability and preparing for the unpredictable in terms of weather and visitation is a business reality for outdoor recreation no matter the cause of change.

The final open-question addressed barriers to change and adaptation in terms of either changing environmental factors or changing visitation. Six of thirteen participants responded no, there are no barriers hindering them from changing their business. The remaining seven commented on issues outside of their immediate control that are influencing their ability to adapt to increases in visitation with the most prevalent issue being infrastructure and building. Participants did not directly connect barriers to adaptation to observed or anticipated manifestations of climate change. The affordable

and overall housing shortage in Moab prevents businesses from hiring and retaining enough staff. Participants are concerned with “the rapid construction of hotels in town” and “the two lane highway being expanded to a four/five lane highway,” because they do not know how current building projects will influence them. Construction of hotels and highways will “create an illusion of room for more people to come visit,” which will make land over-use hard to reduce. “There is just too many people driving, hiking, climbing, and riding here to really try to minimize the effect.”

The only expressed barrier to participants’ ability to adapt to manifestations of climate change was politics. Some small businesses noted how they are at “the mercy of land agencies” and “the political context of Utah and of the United States,” because these systems are “notoriously slow to respond to issues.” “From a small business standpoint... [governmental] change is slow, hard to affect, volatile, and wrought with challenge.” Participants commented on their limited power to influence governmental change, especially with land agencies that control permits that allow them access to public lands during specific months.

Models and Survey Comparison

In the surveys, the majority of business operators indicated that November, December, January, and February were the months businesses closed or suspended certain activities and services. Comparing this to the Canyonlands National Park model, visitation for winter months (December, January, February) and November was lower than most other months spring, summer, and fall. Arches National Park, showed similar results with November, January, and February having lower levels of visitation than other

months in the year. Business operators believe November to February are too cold and wet for high levels of visitation, and the long-term average temperature shows that these are historically the coldest months in the region (Table 2). Low visitation to national parks in the Moab region during November, December, January, and February lines up with business closures and responses that noted less tourism for those four months.

March to April was the start of the busy season for recreation and tourism businesses. Arches and Canyonlands National Park visitation increases starting in March, and continues increasing in April, which aligns with the start of the busy season for tourism and outdoor recreation business operators. The main time frame for recreation and tourism business activities is from the end of March through October. Looking at the Arches National Park models, March through September are the months with the highest levels of visitation. The Canyonlands National Park visitation resembles the busy months operators have from March to October. The survey and model results suggest that visitation to the area around Moab is higher for the months of March through September, and potentially high for October.

The busiest part of the tourism season for various types of businesses was March to May starting with Spring Break (mid-March), and September to October. The Arches National Park model has a similar busy season from March to May and September to October, with June also receiving considerable visitation. Start and end times for the water tour season greatly reflect the high visitation patterns for the Arches National Park model with a start time between March and May, and end times in October. Businesses specializing in land tours have start and end times that slightly reflect the same trend, but

they tend to open earlier (end of February) and close later (between October and November). May has the highest national park visitation numbers, which parallels the survey responses where May is considered one of the busiest months.

DISCUSSION

Seasonality, Visitation, and Climate

Visitation to the national parks that surround Moab has been increasing over the last 38 years. Expected temperature is positively correlated to monthly visitation for Arches National Park and Canyonlands National Park. The results for both models are comparable to the findings of Richardson and Loomis (2004), Scott et al. (2007), and Fisichelli et al. (2015), where increases in temperature are related to increases in visitation. The trend of increasing temperature stimulating increases in visitation is a perception also held by business survey respondents. Generally warm temperatures are believed to have a very positive influence on tourism.

The long-term average temperature and the temperature anomaly are both significant in the Arches National Park model, which shows that the expected and the actual temperature for a month are positively influencing visitation to Arches National Park. This trend is not present for Canyonlands National Park. The temperature anomaly does not significantly influence Canyonlands National Park visitation, while the long-term average temperature does heavily influence visitation. For Canyonlands National Park, these results suggest that the expected temperature for a month has a positive relationship with visitation. Instead of planning a trip using the actual temperature of the month, visitors are likely planning their trips in advance based partially on the expected temperature for Canyonlands National Park. Within the context of this research, no data was collected on any basis on which to interpret the differences between national parks

more thoroughly such as higher visitation by car or ability to choose alternate activities based on temperature.

The large majority of responses noted a longer season or no change to their seasons. The businesses that did not experience change mentioned a history of always closing during colder months. Some of the businesses noted that unpredictable weather potentially altered start/end times, but the popularity of Moab and advertising were believed to be the driver behind extending the tourism season. Warmer winter temperatures and an earlier start to spring are believed to have increased the shoulder season and encouraged tourism in the desert; however, popularity/advertising are perceived as the primary force behind seasonal visitation changes. The belief that advertising and popularity are the main drivers behind more visitation and a change in seasonal visitation was not expected considering the results of other research that have highlighted the strong relationship that temperature and climate change have with visitation and tourism (Scott, Jones, and Konopek 2007; Buckley and Foushee 2012; Fisichelli et al. 2015; Copeland et al. 2017). Fisichelli et al.'s (2015) research noted that with warmer temperatures in parks, there is the potential for an overall increase in visitation throughout the season, while Scott et al. (2007) found that climate directly influences outdoor recreation and tourism by increasing and limiting activities and demand.

The models do not capture the effects of extremely high temperature days, but participants in the survey perceived high temperatures as deterrents to visitation for certain parts of a month or parts of a day. Temperature being too hot influences the

number of people booking tours and a business's ability to execute activities. Summer tourism may decrease for certain activities or times of day due to high temperature. July and August were noted by participants as the months when high temperatures can slow recreation visitors, and force visitors to shift to other types of tourism like sight-seeing recreation by car or to plan activities outside the hottest part of the day. The survey results support research by Richardson and Loomis (2004), which noted the negative effect extreme heat has on visitation. The survey results for RMNP indicated that visitors would be deterred from visiting the park if the temperature reached over a certain threshold (Richardson and Loomis 2004).

The findings that air temperature is a good predictor of visitation also support Smith et al.'s (2018) research, which found that the monthly average of the daily maximum temperature was a great predictor of visitation to Utah's national parks including Arches and Canyonlands. Smith et al.'s (2018) research also found that visitation does have a daily max temperature threshold between 25°C and 33 °C, so that temperatures above are related to a decline or leveling off in visitation numbers for Utah national parks.

Operator Perceptions of Climate and Adaptation Strategies

The type of activity did not affect the operator's perception of the influence of environmental factors on their business. The majority of participants do not believe that changes in environmental factors influence most aspects of their business: employment, sales, operating costs, types of activities offered, and visitation. However, a third of responses do believe that there was an increase in the 'seasons for activities' due to

changes in environmental factors and climate. Over half of the participants (68.6%) believe changes in climate have affected their business a little to a moderate amount. The closed ranked responses contrast with some of the open written responses that noted how warmer winters and a longer season are positively influencing business and visitation.

The contrasting responses highlight the potential for a disconnect or dual perceptions between how businesses do not believe aspects of their operations are influenced by changes in environmental factors and climate, and the changes they report they are perceiving in their environment. The reason for respondents separating changes in operations and climate change could have to deal with the high level of flexibility businesses possess. Some business operators acknowledge that they expect the environment and visitation to be constantly changing, so they must be flexible to accommodate. Responses emphasized handling challenges as they are presented and instituting changes in anticipation of trends. Operators inherently have to build flexibility into their businesses in order to overcome sudden changes that impact their businesses directly. The majority of business operators are not concerned that environmental factors will influence their businesses in the future.

Future environmental factors that participants were concerned about revolved around water access and dependence in terms of snowpack. In years with low snowpack, revenue for snow- and water-based recreation businesses is generally lower compared to wet years, which has the potential to threaten profit margins (Alvord et al. 2008). Water tourism relies on snowpack and river water levels, so a lack of snowpack can negatively impact the ability to provide river trips. Low snowpack is viewed as detrimental to

Moab's water supply, because the aquifers and Colorado River in the region are supplied by snow melt. Diversification of types of tourism activities is an adaptive strategy some businesses have taken to accommodate increased visitation, but it could be utilized to adapt to low water levels. These adaptive strategies are similar to suggested alternative activities or diversification tactics for dry regions mentioned by Alvord et al. (2008) and Wyss et al. (2015). The revenue base can be expanded by taking advantage of warm and dry conditions from spring to fall.

The theme of adaptability and flexibility to climate change, weather, and environmental factors was very strong among participants. Current adaptive plans and strategies to address changes in visitation and environmental factors varied heavily from no change in business practices, to changing seasons and hours for activities, increasing investments (purchasing recreation equipment, vehicles, and offered rental equipment; expanding building space), diversifying, and communication. For some, these adaptation practices are a response to having a longer season for outdoor recreation and for others they are a response to visitation increases. Participant responses were generally not explicit enough in describing the exact goal of the adaptation strategy. Businesses without plans to change emphasized how positive increasing visitation is for business and how their businesses have always possessed a high level of flexibility.

Current adaptive strategies regarding seasonality and hours of operation included changing tour hours to avoid summer heat, starting business earlier in the season, and extending the tourism season. Fisichelli et al.'s (2015) results suggested that community decision makers may need to exploit increased recreation in shoulder seasons (spring and

fall) to adapt to the impact of changing visitation, which is an adaptive practice Moab business operators have implemented. To adapt to increases in visitation, businesses are potentially opening earlier in the spring and staying open later into the fall. Additionally, operators link changing seasonality and hours of activities to employment and staffing needs. Employees are hired and trained to start earlier and end later in the season, with increases in the number of staff to adapt to increasing visitation. Businesses unable to hire sufficient staff for the extended season close operations early. Increasing investments, increasing staff, and offering more or diverse types of tours are linked adaptation strategies that all types of businesses can use to capitalize on visitation growth. However, some respondents are concerned that increases in visitation will cause environmental over-use. In terms of future adaptive strategies or plans to address changes in visitation or climate change, the majority of participants do not have future plans. The types of future adaptive strategies that operators did mention closely resembled what businesses are already implementing.

To fully understand adaptation practices and strategies businesses in Moab consider, barriers to change and adaptation have to be known. Half of operators responded no, there are no barriers hindering them from changing their business, while the remaining reported on issues outside of their immediate control that influence their ability to adapt to changes in visitation and environmental factors. The most prevalent barriers to change were infrastructure and building in the region, which constrained the businesses ability to respond to change more broadly. The barriers respondents noted did not directly relate to adapting to climate change specifically. Tourism dependent

communities are challenged in retaining permanent residents year round (Alvord et al. 2008). Affordable housing and the housing shortage in Moab prevents businesses from hiring enough staff and retaining guides. There is also concern for infrastructure stress in the area due to increasing visitation with highways expanding, construction of hotels rising, and new tour companies, which will make land over-use hard to reduce and place stress on infrastructure that has not expanded to accommodate more visitors.

The barriers to change that related to climate change were the over-use of the environment and current U.S. politics. Owners were concerned about environmental over-use by humans in a fragile desert ecosystem. There is worry that over-visitation to the region will destroy the places people come to recreate in and visit. In terms of politics, land agencies, Utah agencies, and U.S. politics are perceived as slow to change, volatile, and hard to initiate change. Business operators feel vulnerable to the influence of governmental change, especially with land agencies that control access and use permits. To a degree, their businesses rely on these governmental agencies to be able to have access to recreational areas for their season. If the season for types of recreation extends for a particular year, operators may not be able to take advantage because permits take time to be processed and issued.

Adaptation to climate change is not the focus for businesses in the Moab region, while adaptation to increases in visitation is a priority for business operators. Even if businesses are not directly adapting to climate change, they are adapting to visitation changes that are highly influenced by temperature. Businesses monetarily benefit from implementing adaptation strategies because these strategies allow them to capture

increased revenue from visitation to the region. In the future, businesses may benefit from alternative types of adaptation strategies to adapt to increasing temperatures and possibly other aspects of climate change, but their current strategies are effective.

Limitations and Future Research

The implications of the research are limited because the case study is geographically specific to Moab and the surrounding national parks, and this region is benefiting from increases in national park visitation. A general limiting factor with using linear regression models is that Smith et al.'s (2018) research suggests that the relationship between temperature and visitation is not linear. Too high temperatures in Utah's national parks was shown to cause visitation to decline or level off (Smith et al. 2018). Future research should examine the extent that model variables interact to influence visitation including climate variables, seasons, and historical trends. Other drivers of visitation that could be included in additional research are amount spent advertising locally and by the Utah Tourism Office. The differences for why temperature anomalies significantly influence visitation to some parks or recreation areas is another variable tourism and outdoor recreation research could pursue to understand visitor behavior. Temperature anomaly also may have a non-linear relationship with visitation and need to be modeled differently, perhaps by taking the absolute value.

More research is needed to understand the influence of extreme temperatures on outdoor recreation and tourism to the region. Several studies have emphasized the positive influence that increases in temperature have on visitation (Amelung, Nicholls, and Viner 2007; Scott, Jones, and Konopek 2007; Fisichelli et al. 2015), and Smith et

al.'s (2018) research has addressed the influence of extreme temperatures on visitors for five national parks, but research is still needed to expand on the influence of extreme temperatures on local recreation and tourism businesses.

For the survey, business participation was lower than expected even with pre-notifications, follow-up emails, and out-reach to business owners. Owners and managers of smaller businesses were difficult to engage through an online survey because they lacked time or perceived themselves as having little to contribute to the research topic. The survey only highlights some of the factors that influence businesses ability to adapt to changing visitation and environmental factors. Interviewing federal land managers, city council members, and other public officials could contribute to our understanding of barriers to change and adaptation plans more thoroughly for the Moab region.

CONCLUSION

This research used multivariate regression analysis to investigate the relationship between air temperature, months, and visitation for Arches National Park and Canyonlands National Park. Temperature anomaly did not have a strong linear relationship with visitation; however, future analysis with the air temperature anomaly with non-linear modeling would be beneficial to further explore the relationship. Long-term average monthly temperature (the expected monthly temperature) has a positive relationship with visitation for Arches National Park and Canyonlands National Park. An operator survey was used to evaluate perceptions of climate change and business adaptation strategies. Business operators corroborated the finding that expected temperature has a positive relationship with visitation through their belief that generally warm temperatures have a positive influence on tourism. In terms of seasonality, November through February were the months businesses closed or suspended services, and visitation to Arches and Canyonlands National Parks was lower compared to in other months. Operators indicated that the reasons for closures were low visitation, lack of winter recreation options, and a desire for time off.

Operators reported the perception that climate change was either leading to a longer recreation and tourism season or was having no impact. At the same time, most businesses operators reported the belief that weather and climate change are not the major factor extending the tourism season and increasing visitation overall, instead they believe the major factor is growing popularity of Moab and increased advertising for the Moab

region as a destination. These apparently conflictual perceptions and beliefs are one key finding of the study. It is possible that the long-term trends in visitation growth unrelated to climate change drown out the signals of seasonality changes related to climate change, affecting operators' perceptions. The primary reason operator responses vary on the influence of climate change appears to be because their business exhibits high levels of flexibility and adaptability, or at least is perceived to possess high levels of flexibility and adaptability.

Business perceptions of high adaptability and flexibility to climate change, weather, environmental factors, and visitation is another key finding. Operators expect weather, the environment, and visitation to be constantly changing, so flexibility is inherent in their business plan. This perception likely does reflect a reality of flexibility and adaptability that can serve as an important resource for climate change adaptation in the outdoor recreation sector of Moab. However, such a perception might also inhibit imperative adaptation planning efforts, if those efforts and plans are therefore seen as unnecessary.

Nature-based tourism and outdoor recreation in Moab, Utah and U.S. national parks are in a constant state of change. Tourism visitation is continuing to increase and seasonality is shifting. Changing climatic conditions also affect and alter the natural environment that attracts tourists. This continuous torrent of change will necessitate further study on climate's influence, community perceptions and strategies to adapt to change. Given the economic importance of tourism to U.S. national parks and their

gateway communities, it is hoped that this study also will encourage future investigations in perceptions of climate change in tourism communities and among stakeholders.

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APPENDICES

APPENDIX A

SCRIPTS FOR ONLINE RESEARCH SURVEY

Pre-Notification/ RecruitmentPhone script:

Hello, this is Elizabeth Cook, a graduate student at Utah State University. May I please speak with the owner or manager?

I am working with Dr. Claudia Radel at USU and we are conducting research surveys with local Moab outdoor recreation and tourism business owners, supervisors, and managers to explore how the tourism and outdoor recreation industry in Moab is experiencing and adapting to changes in climate and shifts in seasonality of visitation. We are hoping you might be willing to help by participating in an online survey. Depending on your answers, we expect this will take roughly 45 minutes. Your identity will be kept confidential.

If you are interested in participating, will you please provide a preferred email address? An email will be sent to your business within a few days. If you are willing to participate, please complete the survey.

If you have any questions or concerns before participating, you may contact Dr. Claudia Radel, at claudia.radel@usu.edu or myself at liz.cook@aggiemail.usu.edu

Thank you.

In-person script:

Hello, this is Elizabeth Cook, a graduate student at Utah State University. May I please speak with the owner or manager?

I am working with Dr. Claudia Radel at USU and we are conducting research surveys with local Moab outdoor recreation and tourism business owners, supervisors, and managers to explore how the tourism and outdoor recreation industry in Moab, Utah is experiencing and adapting to changes in climate and shifts in seasonality of visitation. We are hoping you might be willing to help by participating in an online survey. Depending on your answers, we expect this will take roughly 45 minutes. Your identity will be kept confidential.

If you are interested in participating, will you please provide a preferred email address? An email will be sent to your business within a few days. If you are willing to participate, please complete the survey.

If you have any questions or concerns before participating, you may contact Dr. Claudia Radel, or myself. Do you have any questions currently? You can reach us at claudia.radel@usu.edu or liz.cook@aggiemail.usu.edu.

Thank you.

Email Scripts

Initial Email Script with Link to Survey:

Dear owner or manager of _ (Business Name) _

I am a graduate student at Utah State University. I spoke with you briefly before about the research I am working on with Dr. Claudia Radel at USU. We are conducting research surveys with local Moab outdoor recreation and tourism business owners, supervisors, and managers to explore how the tourism and outdoor recreation industry in Moab, Utah is experiencing and adapting to changes in climate and shifts in seasonality of visitation. We are hoping you might be willing to help by participating in an online survey. Depending on your answers, we expect this will take roughly 45 minutes. Your identity will be kept confidential.

Attached to this email is a Letter of Information that gives more detail on the research and what your role would be if you chose to participate. If you have any questions or concerns before participating, you may contact Dr. Claudia Radel, at claudia.radel@usu.edu or myself at liz.cook@aggiemail.usu.edu

If you are willing to participate in the online survey, please click the link below.
(Link to Qualtrics survey)

Thank you.

Follow-up Email Script with Link to Survey:

Dear owner or manager of _ (Business Name) _

I am a graduate student at Utah State University, my name is Elizabeth Cook. You may

have received several emails about the research I am working on with Dr. Claudia Radel at USU. I am emailing you as a reminder about the survey.

Summary about the research:

We are conducting research surveys with local Moab outdoor recreation and tourism business owners, supervisors, and managers to explore how the tourism and outdoor recreation industry in Moab, Utah is experiencing and adapting to changes in climate and shifts in seasonality of visitation. We are hoping you might be willing to help by participating in an online survey. Your identity will be kept confidential. Depending on your answers, we expect this will take less than 45 minutes.

The Letter of Information, provided on the first page of the survey, has more detail on the research and what your role would be if you chose to participate. Please take the time to read the document. If you have any questions or concerns, you may contact Dr. Claudia Radel, at claudia.radel@usu.edu or myself at liz.cook@aggiemail.usu.edu.

If you are willing to participate in the online survey, please click the link below.
(Link to Qualtrics Survey)

We greatly appreciate your interest in the survey. Thank you.

APPENDIX B

ONLINE SURVEY FOR TOURISM AND OUTDOOR RECREATION BUSINESSES

Please fully review this Letter of Information document before deciding to proceed with this survey. (Embedded Letter of Information)

Informed Consent: By continuing, you agree to participate in this study. You indicate that you understand the risks and benefits of participation, and that you know what you will be asked to do. You also agree that you have asked any questions you might have, and are clear on how to stop your participation in the study if you choose to do so. Please be sure to retain a copy of this form for your records.

Q1. What is your full name? (First and Last)

Q2. What is the name of the business or organization you are associated with?

Q3. What is your position within the business?

Q4 How many years have you owned or been a part of this business?

Q5. What type of tourism or outdoor recreation services does the business provide?
(Check as many as apply)

- ☐ Guided Trips and Tours (1)
- ☐ Self-Guided Trips (2)
- ☐ Water Tours (3)
- ☐ Aerial Tours (4)
- ☐ Land Tours (5)
- ☐ Mountain Biking Tours (6)
- ☐ Photography Tours (7)
- ☐ Off-Roading Tours (8)
- ☐ Hiking Tours (9)
- ☐ Educational Tours (10)
- ☐ Horseback Riding Tours (11)
- ☐ Rafting, Canoeing, Jet Boat Tours (12)
- ☐ Rentals - Vehicles, Bikes, Water Crafts (13)
- ☐ Rentals - Equipment and Gear (Climbing, Camping, Snow Sports, Individual Outdoor Gear) (14)

Q6. Please briefly describe the business in 2-3 sentences.

Seasons

Definitions:

Season - A period of the year during which an activity is best performed.

Example: The back country skiing season regularly runs between October and February each year.

Q7. What are the seasons for activities your business participates in throughout the year? Please explain the start and end times in terms of months.

Q8 Over time, has your business experienced a change in the start or end of certain seasons? If yes, please describe the change.

Q9. If you have experienced changes to the start and end of certain seasons, to what do you attribute these changes?

Q10 If you close your business or suspend recreation activities, during which months (include partial months) of the year do you typically close?

- ☐ January (1)
- ☐ February (2)
- ☐ March (3)
- ☐ April (4)
- ☐ May (5)
- ☐ June (6)
- ☐ July (7)
- ☐ August (8)
- ☐ September (9)
- ☐ October (10)
- ☐ November (11)
- ☐ December (12)

Q11. Please describe the nature of the closures for selected months.

Environmental Considerations

Definitions:

Environmental Factors - Known characteristics in an environment that impact the conduct, operations, and success of human activity. External conditions or surroundings such as temperature, rainfall, snowfall, and river water levels.

Climate - The weather conditions that prevail over an area generally or over a long period of time.

Season - A period of the year during which an activity is best performed.

Example: The back country skiing season regularly runs between October and February each year.

Q12. How would you characterize the effect on your business of the following environmental factors or conditions?

	Very Positive (1)	Positive (2)	No Effect (3)	Negative (4)	Very Negative (5)
High Temperatures (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Low Temperatures (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unpredictable Temperatures (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High Water Levels and River Flow (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Low Water Levels and River Flows (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unpredictable Water Levels and River Flow (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased Yearly Rainfall (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decreased Yearly Rainfall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(8)					
Unpredictable Rainfall (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased Snow Pack (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decreased Snow Pack (11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q13. How have the following aspects of your business been impacted by changes to temperature, rainfall, water levels, or snow pack?

	Large Increase (1)	Increase (2)	No Effect (3)	Decrease (4)	Large Decrease (5)
Employment (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sales (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Operating Costs (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Profits (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Seasons for Activities (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Type of Activities Offered (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visitation (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q14 Changes in climate can include shifts in rainfall, snowfall, and temperature. Based on your own experiences, how much have changes in climate affected your business?

- ☐ A great deal (1)
- ☐ A lot (2)
- ☐ A moderate amount (3)
- ☐ A little (4)
- ☐ None at all (5)

Q15. Please describe the changes that you have experienced and how they have affected your business.

Q16 How has visitation changed for your business, as environmental factors have changed during different seasons? Please indicate the timescale over which you have noticed these visitation changes, e.g., since 2007, or over the last 3 years.

Q17 How concerned or worried are you about environmental factors influencing your business in the future? Please briefly explain.

Adaptations

Definitions:

Environmental Factors - Known characteristics in an environment that impact the conduct, operations, and success of human activity. External conditions or surroundings such as temperature, rainfall, snowfall, and river water levels.

Q18 Thinking about changes in visitation and/or environmental factors, are there adaptive strategies or plans the business is currently using? How has your business responded to changes in visitation and/or environmental factors throughout the year? Please explain in detail.

Q19 Thinking about changes in visitation and/or environmental factors, are there adaptive strategies or plans the business is considering using in the future? Please explain in detail.

Q20 Are there changes you would like to make to adapt to either changing environmental factors and conditions, or changing visitation, but cannot currently make? What are these changes and why can you not make them currently?

Research Findings:

Once the research study is complete, the researchers can email you findings of the study related to your participation. If you would like to be notified of completed research, please indicate your interest and include your contact information at the bottom.

Yes, I would like to be notified of completed research. (1)

No, I would not like to be notified of completed research. (2)

Future Participation:

The researchers would like to keep your contact information in order to potentially invite you to participate in follow-up research related to this same study. If you would like them to keep your contact information, please indicate your interest below and include your contact information at the bottom. This information will be entered into a digital Excel file that is completely separated from anything to do with this research study and maintained for a year after surveys are collected, until August 2018. You can contact the Principal Investigator, Claudia Radel, at any time to be removed from this list.

Yes, I consent to being contacted for participation in related follow-up research. (1)

No, I do not consent to being contacted for participation in any related follow-up research. (2)

Contact Information:

If you indicated above that you would like to be contacted to receive study findings when they are completed or are willing to participate in follow-up research, please include your contact information below.

Full Name (1)

Phone Number (2)

Email Address (3)

Thank you for participating in this research survey.